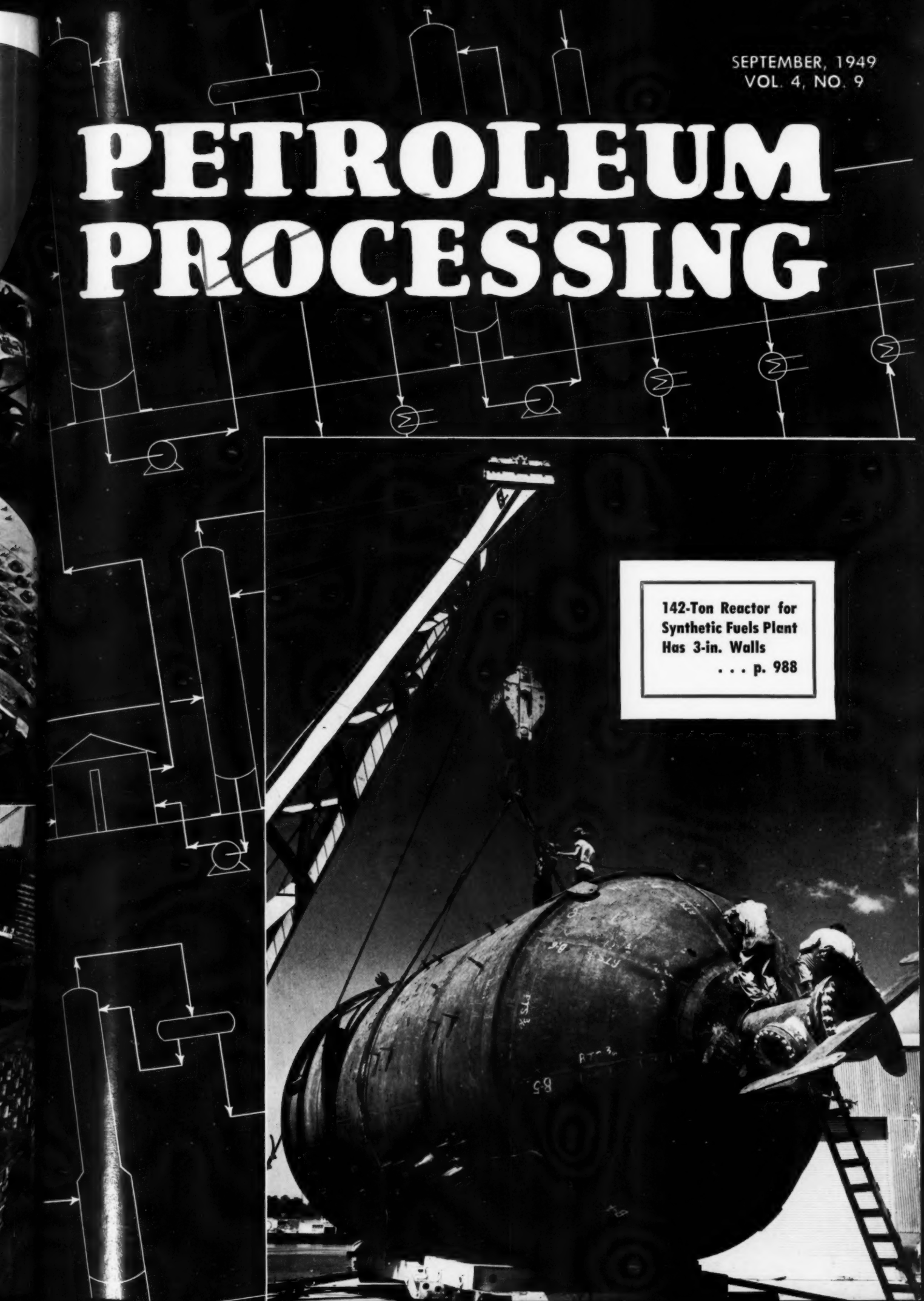
SEPTEMBER, 1949
VOL. 4, NO. 9

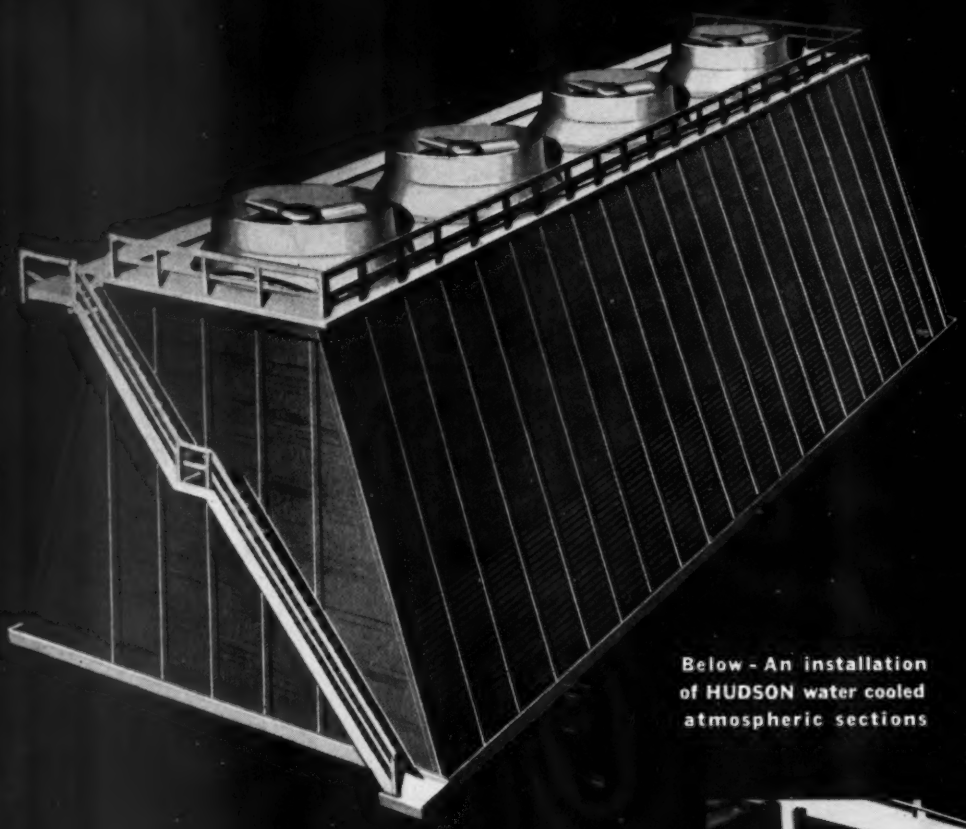
PETROLEUM PROCESSING



142-Ton Reactor for Synthetic Fuels Plant Has 3-in. Walls
. . . p. 988

NEW HUDSON

Top Performance COOLING TOWERS



Below - An installation of HUDSON water cooled atmospheric sections

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LOWER OPERATING COST

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The Ethyl Technical Man brings the refiner

26 YEARS OF RESEARCH EXPERIENCE

Twenty-six years of extensive fuel-engine research work at Ethyl have built up vast files of basic information on fuels and engines. These are being continuously expanded by the addition of results from current programs. Making this material useful to oil companies is the full-time work of a staff of Ethyl Technical Representatives.

The dual function of this group is:

1. **To interpret Ethyl's accumulated technical information in the light of each refiner's specific problems, as an aid to the economical production of satisfactory fuels for today's and tomorrow's automobile engines.**
2. **To keep the Ethyl Laboratories informed on the problems and technical interests of the oil companies as a guide to the formulation of Ethyl's research objectives and programs.**

The technical information in the files of the Laboratories covers a wide range of subjects related to the problems of refining gasoline. More important, however, than the knowledge accumulated on individual subjects is the understanding acquired of the many complicated interrelationships of engines, fuels, and lubricants.

Ethyl Technical Representatives have all had long experience in the Research Laboratories and have helped to develop the information which they now make available to refiners. All the extensive technical data kept in the Ethyl research files and all the results of current research programs are available to these technical representatives.

Because they are so thoroughly informed on Ethyl's research activities, they are of maximum help to refiners on problems related to the utilization of gasoline in engines. If a refiner's particular problem makes desirable a discussion between his specialists and Ethyl Research specialists in the same field, the Technical Representative is usually able to arrange such a meeting.

The wide experience of Ethyl Technical Representatives and their familiarity with Ethyl's research programs contribute to one of Ethyl's most important research objectives—

developing and distributing information to assist refiners in economically producing satisfactory gasoline.

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Write for bulletin FR-3 which gives further details on Wiggins Lodek Floating Roofs.

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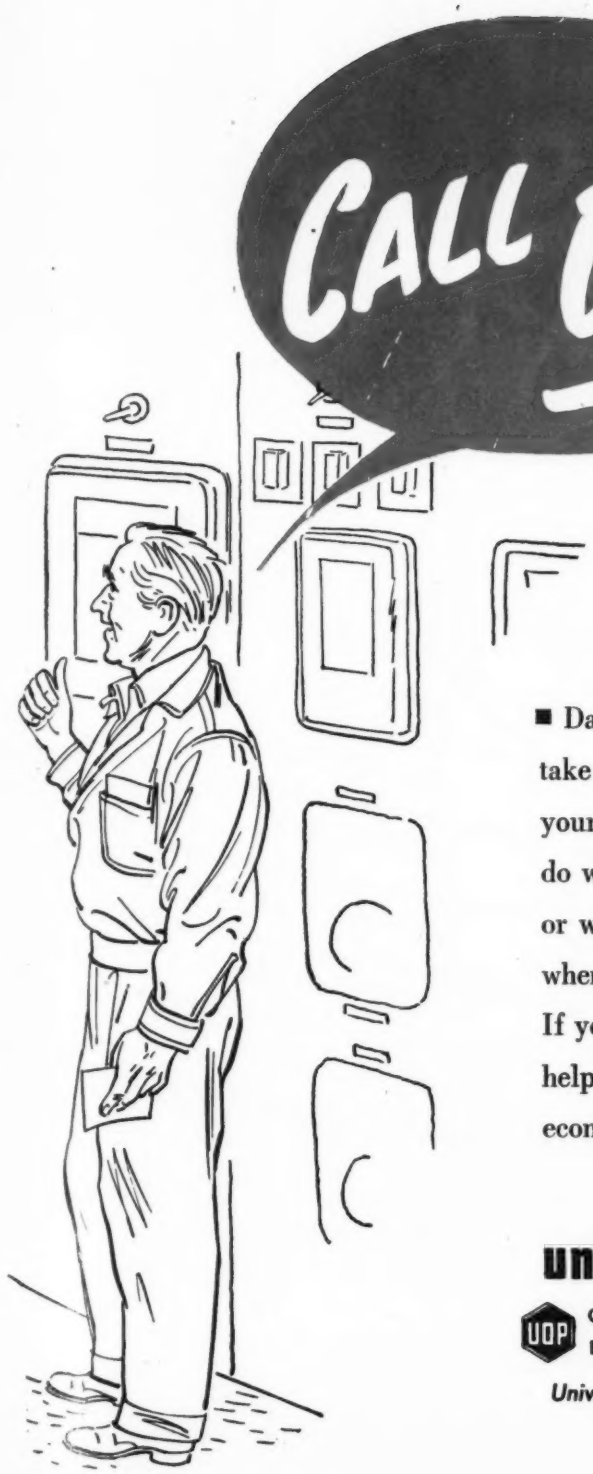

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CHEMICO PLANTS ARE PROFITABLE INVESTMENTS

What's Happening!

Important Current News Summarized for Refiners

EXPANSION

Union Oil Co. is planning to start construction in the near future on a new coking unit at its Wilmington, Calif., refinery. The company several months ago announced a 3 to 4-year program to increase light distillate production by 50% at the expense of heavy fuels, and is now rumored to be readying a $40,000,000 expansion project to achieve this goal.

California Refining Co. will increase present 25,000 b/d crude processing capacity of its Perth Amboy, N. J., plant to 50,000 b/d, according to New York trade sources, although the company itself would neither confirm nor deny the rumor. According to reports, the job will cost $25 to 30 million, require two to three years for completion, and include a crude distillation unit, cat cracker, polymer plant, several gasoline treating plants, and auxiliary facilities.

Salt Lake Refining Co. has awarded contract for design and construction of a 10,000 b/d Houdriflow catalytic cracking unit to Bechtel Corp., San Francisco, as part of its $10,000 expansion program.

• • •

NATURAL GASOLINE

Humble Oil & Refining Co. is now operating its combination natural gasoline and pressure maintenance plant near Picton in East Texas. Built by Fluor Corp., Ltd., the plant handles 18,000 Mcf of gas daily, producing 13,250 gal. of propane, 11,500 gal. of butane, and 9000 gal. of natural gasoline. Operating pressure is 700 psi., and injection gas is supplied at 2700 psi. Ultimate design capacity is 30,000 Mcf.

Del Ray Petroleum Co. is building a 25,000 Mcf gasoline plant in Colorado county, Texas, 60 miles west of Houston. O. L. Olsen, Houston, is contractor. Del Ray is dismantling its 12,000 gal. per day plant in Liberty county for some equipment for the new plant.

Warren Petroleum Corp. is operating its 81,000 Mcf. light hydrocarbon and repressuring project near Maysville, Okla. for the four other owners. Production is approximately 225,000 gal. per day of liquid hydrocarbons. Project consists of a 13 Mcf. plant at Maysville, which also provides circulating absorption oil and fractionating facilities for the entire project, and two remote compression and absorption plants at Antioch (31,000 Mcf.) and Lindsay (26,500 Mcf.)

Richardson & Bass, Fort Worth, has requested permission of Texas Railroad Commission to inject LPG into leases in the Keystone field, Winkler county, West Texas, at the 1750-foot level until market for the gas is available.

• • •

FOREIGN

ECA has approved two projects for rehabilitation and modernization of refining facilities in France:

The 8000 b/d Donges refinery of Raffineries Francaises de Petrole de l'Atlantique will be increased in capacity by nearly 100%. Lube oil capacity will be increased from 14,000 to 38,000 metric tons per year.

Cracking unit at the La Mede refinery of Compagnie Francaise de Raffinage will be altered to process distillates from Middle East crude, and new facilities will be installed at the same company's Gonfreville plant to produce 120,000 metric tons of lube oils and 10,000 tons of wax per year.

STANIC, new Italian company jointly owned and operated by Jersey Standard and the Italian-owned company of ANIC, is increasing its capitalization from $35,000 to $21,000,000 for modernization of its refineries at Leghorn and Bari, Italy. No specific projects have yet been announced for the two plants, which today have a combined capacity of 16,000 b/d.

Puerto Rican Oil Refining Co., a new firm, will construct a 25,000 b/d refinery costing an estimated $20 million near Ponce, Puerto Rico, according to Lyford and Eberle, New York consultants. The plant is expected to be operating by late 1950 or early 1951, and will process foreign crude, probably Venezuelan.

• • •

MARKETS, PRICES

Reversal of price trend in distillate fuels, downward since late spring, highlighted oil markets pricewise in August. Rising prices for, and increased trading of, the burning oils made for unusual activity in what has been historically a dull vacation month.

A full 1c rally, to 7c per gal., in the cargo price for No. 2 fuel at the Gulf touched off a general increase in wholesale prices for the same product in eastern seaboard marketing areas, averaging about 0.5c per gal. At New York Harbor, No. 2 went from 6.6c to 7.3c per gal. In the Midwest and Mid-Conti-

Information on these pages is obtained through the nation-wide news coverage services of PLATT'S OILGRAM NEWS

nent, No. 2 prices generally were up 0.25c to a group 3 low of 6.25c.

Gulf cargo price for kerosine also jumped, from 6.75c to 7.375c, as offerings dried up during last half of August.

California cast a shadow over residual fuel markets at the Gulf and in the East. Developments for nearly a year have pointed to excessive production of heavy fuel-bearing crudes on the West Coast. And Union Oil Co. of California in late August disclosed that it had concluded agreements with eastern buyers to ship them approximately 2,000,000 bbls of "C" fuel.

Prices for the transaction were not made known, but New York trade reports said they were approximately $1.55 per bbl., delivered, with transportation cost of approximately 80c per bbl. Some 3,000,000 additional barrels of Bunker "C" are said to be available to eastern buyers from California suppliers as PETROLEUM PROCESSING goes to press.

Other highlights in August: CRUDE—paying of premiums for East Texas oil bobbed up again, 10 to 15c per bbl. TEL—price increases of about 3.5% by Ethyl, about 5% by du Pont, effective Oct. 1. GASOLINE—prices and supplies ease; Armed Services Petroleum Purchasing Agency sought 1,430,000 bbls. of motor fuel for last four months of year, was offered 4,030,000 bbl. LUBES—South Texas Pale and Red Oil prices down in amounts ranging from 0.5c to 1.5c per gal.; Penna. prices firm; Mid-Continent easier.

• • •

OPERATIONS

Continental Oil Co.'s expanded facilities are scheduled to go into operation Sept. 26. Costing $8,000,000, they will boost crude throughput at the firm's Ponca City, Okla. refinery to 52,000 b/d (now 33,000 b/d). Included are a 30,000 b/d crude topping unit and modernized TCC facilities.

Esso Standard Oil Co. now is operating its new 49,000 b/d vacuum pipe still at Bayway, the first of three new units under construction. Expected to be in operation by early fall are a 41,000 b/d Fluid unit and a light ends plant.

Shell Oil Co. has completed its new solvent wax plant at Houston, producing 75,000,000 lbs. annually of paraffin and microcrystalline waxes.

• • •

PETROCHEMICALS

Mississippi Chemical Corp. has awarded Girdler Corp. a $5 million contract for an ammonia plant at Yazoo City, Miss. Construction is expected to begin in the fall.

Dow Chemical Co. will spend $5 million at Shreveport to construct a 100-ton-per-day ammonia plant, utilizing hydrogen from the company's chlorine plant nearby and combining it with atmospheric nitrogen by the Haber-Bosch process.

Lion Chemical Co.'s expansion project at Eldorado, Ark., is now completed, including sulfuric acid, ammonium sulfate and ammonium nitrate prilling plants, in addition to added ammonia capacity. Total capital investment is approximately $6,500,000.

Phillips Petroleum Co. has started operating its newly modernized catalytic ethylene alkylation unit at Phillips, Texas, for the production of di-isopropyl alkylate (principally 2,3-dimethyl butane, similar to "neohexane"). Plant has been shut down since shortly after VJ-day.

• • •

TRANSITION

Caminol Oil Co. has sold its 5000 b/d refinery at Sante Fe Springs (Los Angeles), Calif., to Rothschild Oil Co. The plant had been shut down for the past year, and Rothschild planned to put it on stream last month.

Pan-Am Southern Corp. has been formed by the merger of Pan American Petroleum Corp. and its subsidiary Root Petroleum Co., both Indiana Standard affiliates. Root operated a 25,000 b/d plant at El Dorado, Ark., and Pan American a 9500 b/d plant at Destrehan, La. President of the new company is Bruce K. Brown, previously president of Pan American, with headquarters at New Orleans.

Cotton Valley, La., Refinery, built by the government as part of the wartime avgas program, has been turned over to Dulien Steel Products, Inc., Seattle, Wash., for re-sale on a commission basis. Original facilities included dehydrogenation (later converted to butylene manufacture), HF alkylation, and TEL blending. Plant is now being offered by Dulien either piecemeal or as a unit.

• • •

MISCELLANY

Pipelines of plastic-impregnated fiberglas fabric pipe and only one-fourth as heavy as a steel line are now undergoing tests at the Army's Engineer Research & Development Laboratories, Fort Belvoir, Va. The rigid fabric pipe of 6-in. diameter weighs only 45 lbs. per 20-ft. section, as compared with 185 lbs. for steel, and has a 1500 psi bursting pressure. Connections are made with aluminum couplings bound to the pipe ends. Also being tested is a 4-in. pipe; 8-in. pipe will be included later. Army is interested in new development for combat cross-country fuel lines.

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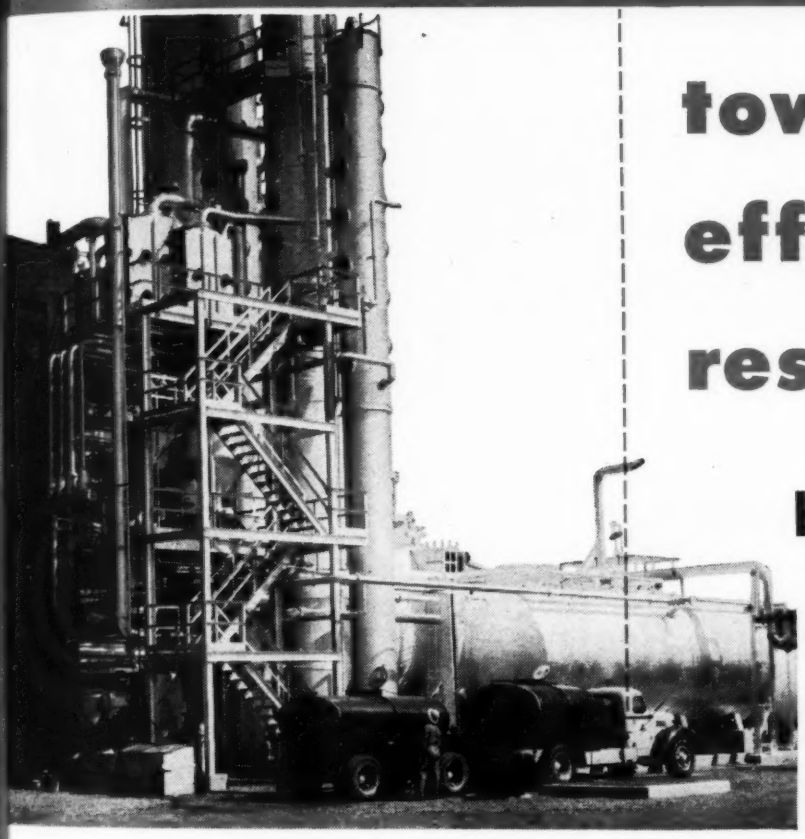

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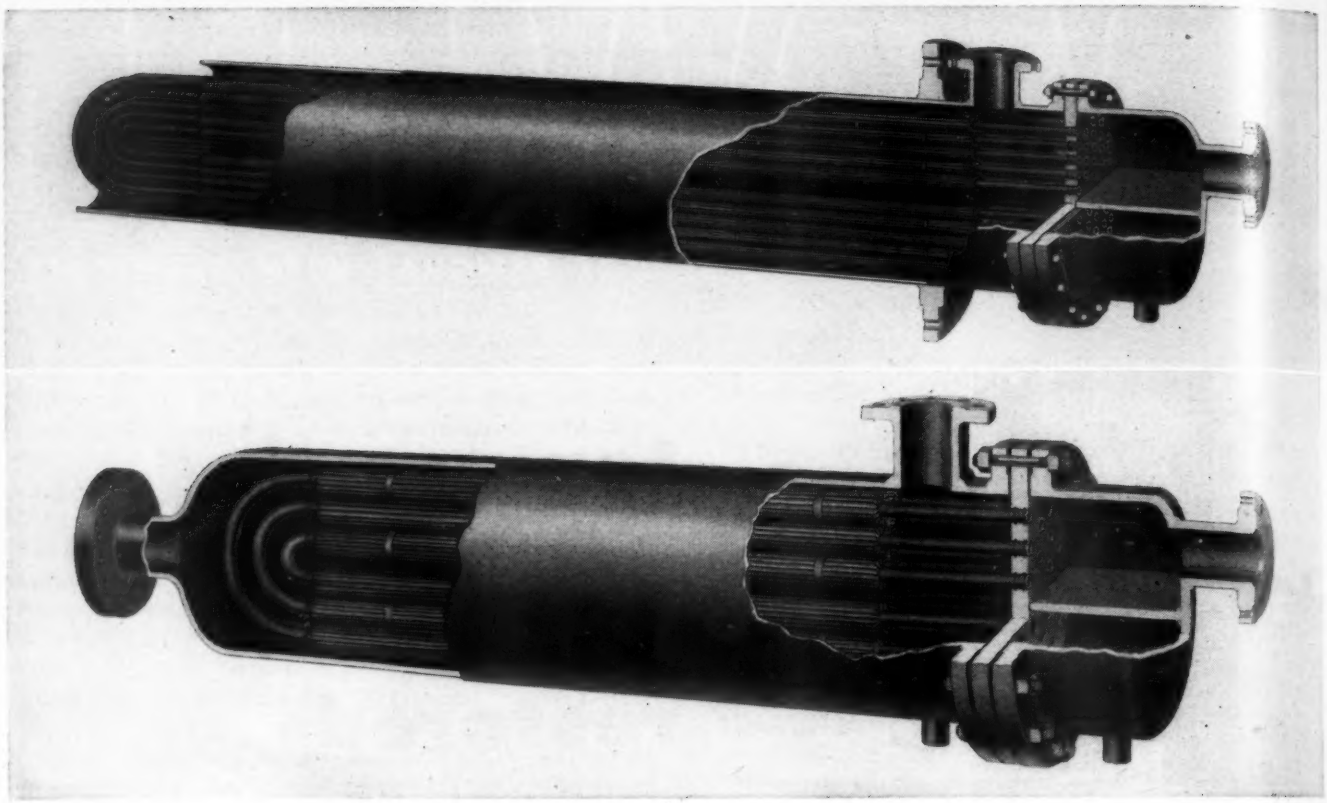

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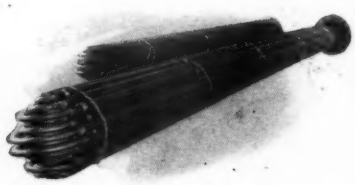

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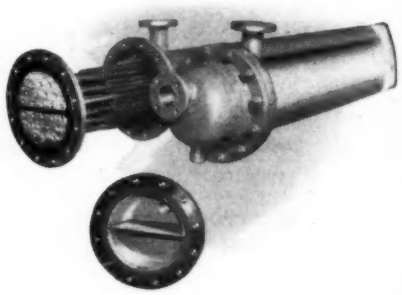

Hairpin Bundle Assembled in Shell Showing Mounting of Tube Sheet Between the Shell and Head.

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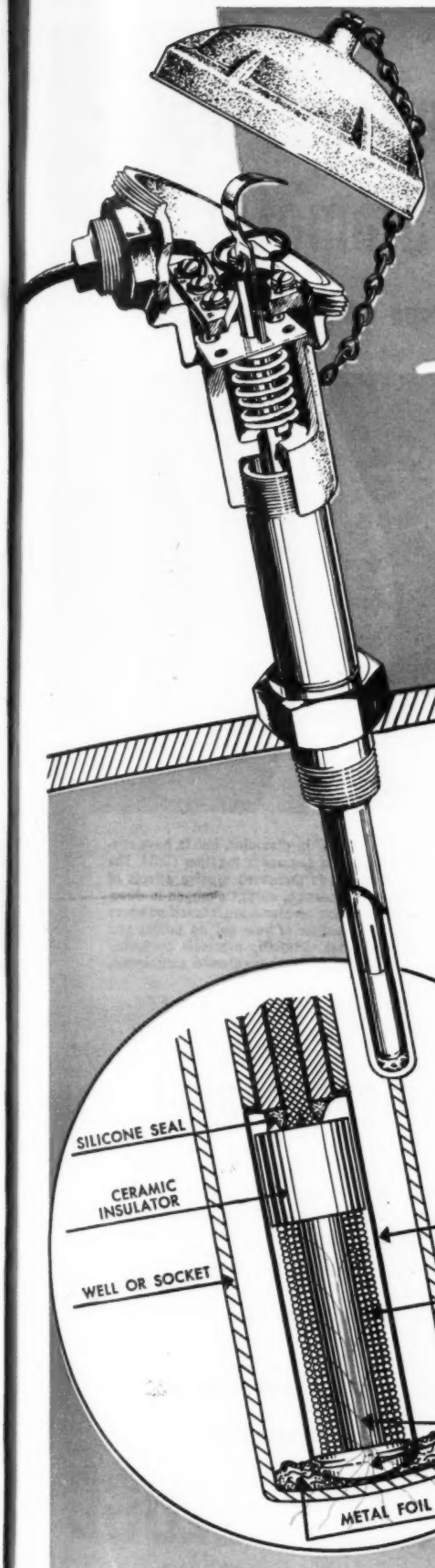

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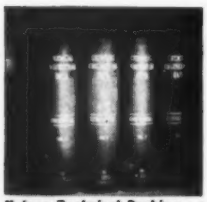

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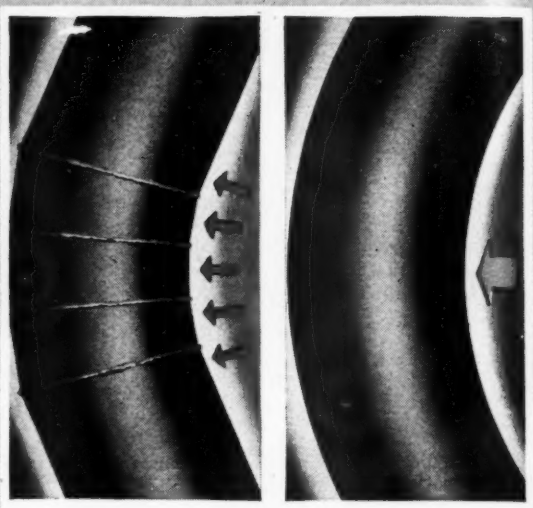
New one-piece giant bends radically reduce erosion and corrosion!



In process pipe larger than 30" in diameter, bends have customarily been made by welding segments together (left). The irregular contour of such bends increases erosive effects of flowing material through successive, abrupt changes in direction of flow. Similarly, corrosion problems are intensified where these sharp changes in direction of flow set up eddies and pockets of corrosive material. Smooth, precisely contoured ONE-PIECE bends reduce erosion and corrosion to a minimum.

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LAST year Kellogg made the first 50-inch one-piece pipe bends—for one of the toughest services imaginable, the main catalyst carrier lines in large Fluid catalytic crackers. Such lines handle more than 600 freight cars of erosive catalyst at 1000°F. in each 24 hours. Mass velocities exceed 4500 lbs. per sq. ft. per minute.

Actual plant service has now provided documentary evidence of the advantages of these one-piece bends. They improve uniformity of flow of powder; reduce pressure drop; radically reduce erosion and thereby eliminate the need for the installation and regular replacement of expensive wear plates required in segmented bends.

Similar advantages are apparent in the handling of corrosive materials. The smooth, regular contours of these *one-piece* bends eliminate the eddying of corrosive material ordinarily present between segments, where changes in direction of flow occur.

While initial costs of these Kellogg *one-piece* bends are roughly comparable to welded-segment bends, ultimate costs, when maintenance and service life are included, show major savings. Kellogg makes *one-piece* bends up to 96" outside diameter.

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Tomorrow
... IN PETROLEUM TECHNOLOGY

By B. H. WEIL, Atlanta, Ga.
Editor, "Monthly Summary of Industrial Developments"

Brief reviews of currently reported technological and economic developments, in the light of their potential bearing on petroleum refining

Lube Oils Defoamed By Activated Charcoal

DURING the recent war, the air forces found themselves faced with serious problems caused by the tendency of aviation lubricants to foam under certain conditions and in certain engine parts. To combat this tendency, at least several petroleum companies conducted concentrated research on the development of foam inhibitors, among the most satisfactory of which are certain silicone compounds.

While some of these inhibitors proved successful in substantially preventing foaming, little was learned on the fundamentals of foaming itself—why oils foamed and how these inhibitors functioned. With these questions in mind, researchers at Stanford University, with the financial assistance of the NACA, have recently gone at the defoaming problem in a different manner, in an attempt not only to develop a defoaming method but also to get basic information. Some of their results have recently been reported.(1)

According to the authors of this bulletin, 90% of the volume of foam normally produced by certain oils at 100° C. can be eliminated by recycling them through a column of activated charcoal at 50° C. or lower. Interestingly enough, a powerful foam inhibitor may be eluted from the charcoal by solvent extraction after its defoaming power has been exhausted, and it is postulated that the charcoal, by catalytic effect, produces such defoamers from the oil itself and eventually has its active surface covered by the inhibitors, blocking formation of additional quantities.

Other defoaming treating agents which can be employed—but with less success—include activated magnesium oxide, silica gel, and Porocel. Extraction of lubricating oils with solvents—liquid sulfur dioxide, phenol, and aqueous sodium hydroxide—failed to produce any significant changes in foaming tendencies, nor did the dispersion of finely divided sodium chloride, followed by filtration, yield any noteworthy result.

Despite the success of the charcoal defoaming method, the authors feel that much further research is required in order to identify and separate from oils those compounds which have defoaming properties, and to gain information on the nature of the defoaming action. Much valuable information may be expected from further study of this problem.

(1) J. W. McBain, *et al.*, Attempts to Defoam Existing Oils by Processing, National Advisory Committee for Aeronautics Technical Note No. 1845, Washington, 1949. 26 pages.

Plastics Manufacturers Actively Battle for Markets

PLASTICS production is today "big business," just as plastics themselves have abandoned the status of novelty materials and have assumed for themselves the role of materials of construction and general use. In fact, so widespread has become the use of plastics that producers of competing materials, in alarm, have been issuing statements advising industries to "go slow" in the use of flexible plastic bottles, sewing boxes, seat covers, dishes, etc. *Modern Plastics*,(2) commenting on this, takes the attitude that plastics producers must meet such challenges with facts and marketing skill, but it also remarks that "competitors who use other materials will produce a never-ending cacophony of sound that will at least serve to let the merchandiser know that his product is making an impression on the field."

As pointed out many times in this series and elsewhere, petroleum refiners are producers of numerous hydrocarbons and petroleum chemicals which are used as plastic raw materials. Output, last year, of many petroleum-based plastics increased markedly, and it is significant that these are the plastics for which future growth prospects are particularly bright.

According to a recent Tariff Commission release,(3) 1948 production of styrene and styrene derivative polymer and copolymer resins totaled 164,676,000 lbs., while that of vinyl and vinyl copolymer resins amounted to 218,237,000 lbs.

(2) Anon., "Battling for Markets," *Modern Plastics* 26, No. 12, 5 (1949).

It is interesting to note, incidentally, that large quantities of plastics are going into the manufacture of transparent packaging films — some 265,000,000 lbs. per year according to Carman of the Plastic Materials Manufacturers Association. Other plastic sheeting and films are also in heavy demand. Moreover, J. R. Hoover of the B. F. Goodrich Chemical Company has recently pointed out(4) that "nearly 40% of our shoe soling is not made of leather . . . Costs to the shoe manufacturer (of the synthetic soles) average about 25 per cent less than for good leather; in the replacement market about 40% less . . . The trend to synthetic upper materials is less advanced than for soling, but development men foresee the eventual solution of difficulties in this large field."

The leather industry is beset by other problems than competition from plastics, but it is not asleep to the danger involved here—in fact, it gives evidence of trying the technique of joining a foe instead of fighting it. Recent experiments reported by the National Bureau of Standards(5) indicate that the abrasion resistance of vegetable-tanned crust leather treated with *n*-butyl methacrylate, polymerized *in situ*, is increased by approximately 75%; treatment with Thiokol LP-2 increased abrasion resistance about 30%.

The plastics field gives no sign, as yet, that it is becoming mature; that future growth will be limited. As a market for petroleum chemicals, plastics production should continue to be of growing interest to the petroleum industry.

Conflicting Views Held On Issuance of Patents

PETROLEUM COMPANIES are vitally interested in judicial attitudes relating to patent grants, and many have been quite perturbed over a trend in recent years which seemingly negates much of the real value of patent acquisition. It is, therefore,

(3) Anon., *Synthetic Organic Chemicals, United States Production and Sales of Plastics and Resin Materials*, 1948 (Preliminary), U. S. Tariff Commission, Washington, 1949. 5 pages.

(4) J. R. Hoover, "Synthetics Invade Leather Market," *Chemical Engineering* 56, No. 6, 138-41 (1949).

(5) Rene Oehler and Timothy J. Kilduff, *Treatment of Leather with Synthetic Resins*, U. S. Department of Commerce, National Bureau of Standards Research Paper RP1951, U. S. Government Printing Office, Washington, 1949. 11 pages. 10 cents.

at least encouraging to note that one New York patent attorney, Robert Calvert, has stated[6] that the Patent Office and the courts seem to be changing their attitude to one of greater consideration for the inventor.

Patents granted in 1947 totaled 20,137, a low for recent years, but the number issued increased in 1948 and is increasing further this year. According to Calvert, the Patent Office seems to be resolving doubt as to patentability in favor of the applicant. Moreover, while the Supreme Court has held only two patents "valid and infringed" since Jan. 1, 1946, and has ruled four patents invalid during this same period, this ratio is said to be on a par with Supreme Court actions since 1900.

John H. Wills, however, in a recent "letter to the editor" of a chemical journal[7] takes a pessimistic view of recent developments. He believes that there has been a great increase in the "number of developments kept secret because the patent grant as interpreted today is an insufficient inducement to disclosure." He states that the number of patents issued per capita has declined steadily since about 1933, after holding level for 50 years prior to that date, and that the number of patents applied for since 1933 has dropped precipitously from 93,000 to 26,000 per year, so that "it seems certain that the number of patents issued next year will be greater than the number of applications filed."

Frank N. Houghton, in a rebuttal[8] to Wills, sharply challenges his statistics. While admitting that there was a marked decrease in the yearly number of patent applications during the recent war, he states that "since then the number has risen to nearly its prewar figure. Approximately 78,000 patent applications were filed in each of the fiscal years ending June 30, 1946 and 1947, and, while I have not seen the official figures since then, I find from checking serial numbers that the rate of filing has continued at over 70,000.

There does not seem to be any slackening in the petroleum industry's attention to patents, largely because the competitive status of individual companies in marketing their products is often greatly influenced by patent holdings.

Antioxidation Additives For Paraffin Waxes

THE petroleum industry, by now, has become part of the chemical manufacturing group—not only because it actually produces chemicals, but also because its major products are no longer the simple, unmodified fractions of crude petroleum. Chemical processes are used in abundance to alter and to improve properties, and chemical additives are now employed in all the major products except simple fuel oils (and even here, potentially at least, when these are to be employed in Diesels, etc.). Petroleum waxes are no exception to the general rule.

It is interesting to note, therefore, that in a recent search[9] for antioxidants for use in "protecting paraffin wax against discoloration and the development of a rancid odor during processing at temperatures above 100° C. . . . 34 phenolic compounds and two xylene-formaldehyde condensation products were evaluated as antioxidants for paraffin wax at 163° C., and several relations between chemical structure and antioxidant efficiency were established. Alkyl substitution in the reactive ortho and para positions and halogen substitution in the para position were shown to improve the stabilizing efficiency of phenolic antioxidants. High activities were observed with bisphenols linked by methylene, sulfur, or thionyl. Increased antioxidant efficiency was also obtained by introducing a second hydroxyl group into a substituted phenol. Substituted resorcinol and pyrocatechol were equally effective. The principles outlined above are applicable to the stabilization of paraffin wax and chemically similar materials."

Other types of antioxidants exist, of course, and additives are now being added to waxes for purposes other than oxidation control. As regards the latter purpose, however, it might be mentioned in passing that recent research has indicated that the onset of rancidity in foods containing fats (butter, etc.) which are packaged in waxed paper may be hastened by oxidation catalysts in the paper and wax. Such catalysis can be inhibited by use of those antioxidants now being added in increasing quantities to foods themselves—propyl gallates, citric acid, ascorbic acid, and the like.

Additive research is still very much a hit-or-miss affair, even when certain principles have been determined and chemical family relationships considered. Those who conduct it for petroleum companies must steer their course through a sea which is largely uncharted, yet dotted with islets of empirical knowledge and shoals of partial information. The results obtained, however, are usually worth the effort.

Coal-Burning Turbine Seen Nearing Achievement

THE possibility of the wide use of coal-burning gas turbine locomotives by the railroads in this country was envisioned by a speaker before the United Nations Scientific Conference on the Conservation and Utilization of Resources.[10] It would then be possible for the railroads to rely upon coal for most of their needs, rather than upon distillate fuels used in Diesel-electric locomotives which are now so rapidly replacing the coal burning steam locomotives.

The achievement which makes this prediction possible is the progress which has been made in finding the means to remove the ash from the coal combustion gases before they enter the turbine, and prevent the scoring of the blades and walls of the turbine. Work to this end has been carried on by the Locomotive Development Committee at its Dunkirk, N. Y., laboratory. Full-scale combustion and ash-removal equipment has been developed as a result of the co-operative program carried out at a number of locations in the country.

The removal of the solid residue from the products of combustion has been accomplished by the use of two-stage ash separation equipment. At the first stage, a louvre-type separator is used to remove the larger ash fragments; in the second stage cyclone separators eliminate as far as possible the finer particles. The work now being carried on at the Dunkirk laboratory is intended to show whether the cleaning which can thus be accomplished is adequate for gas turbine operation. "Major problems of control, ash disposal, and so on still lie ahead but the results accomplished up to the present time are encouraging . . . The major problem . . . is to determine the effect upon the turbine blades of the ultra-fine ash which cannot be removed with conventional equipment. The same problem, however, confronts the users of heavy oils which contain high percentages of ash. Certain forms of oil ash cause serious building up of solids on gas turbine components. Other types of oil ash, however, do not cause this trouble. Much wider experience is necessary before the cause and cure of this difficulty can be specified."

The gas turbine locomotive would prove an important means of fuel conservation, using either coal or heavy oil for fuel, for at the present time the only way by which the railroads can utilize these fuels is with inefficient steam locomotives.

(6) Robert Calvert, "Changing Standard of Invention," *Chemical Industries* 64, No. 4, 576-77 (1949).

(7) John H. Wills, "Letter to the Editor," *Chemical and Engineering News* 27, No. 15, 1088 (1949).

(8) Frank M. Houghton, "Letters to the Editor—Patent Applications," *Chemical and Engineering News* 27, No. 19, 1396 (1949).

(9) Herbert Morawetz, "Phenolic Antioxidants for Paraffinic Materials," *Industrial and Engineering Chemistry* 41, No. 7, 1442-47 (1949).

(10) John I. Yellott, "Future Trends in Fuel Utilization and Consumption," paper prepared for presentation at the United Nations Scientific Conference on the Conservation and Utilization of Resources, Lake Success, N. Y., Aug. 17-Sept. 6, 1949.

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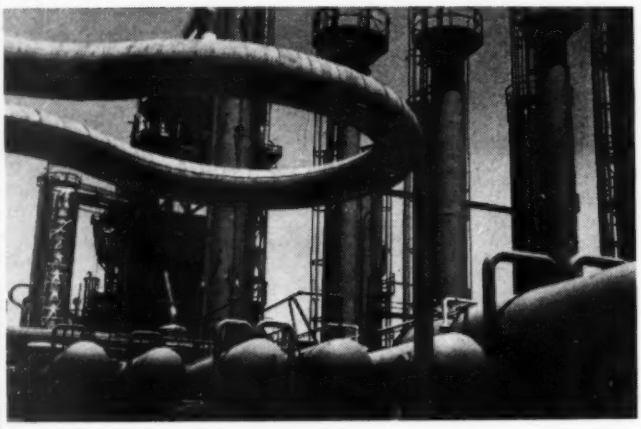

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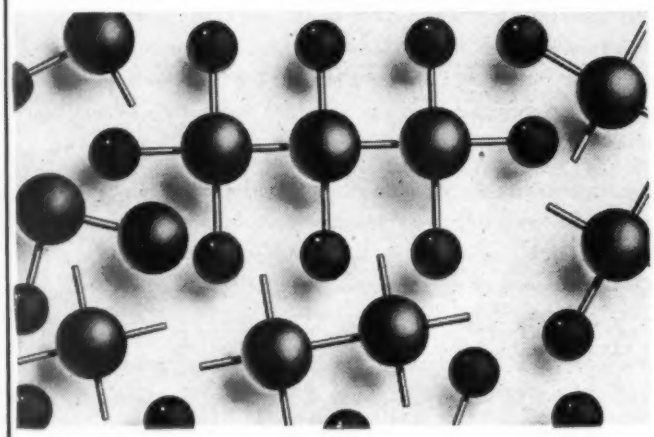

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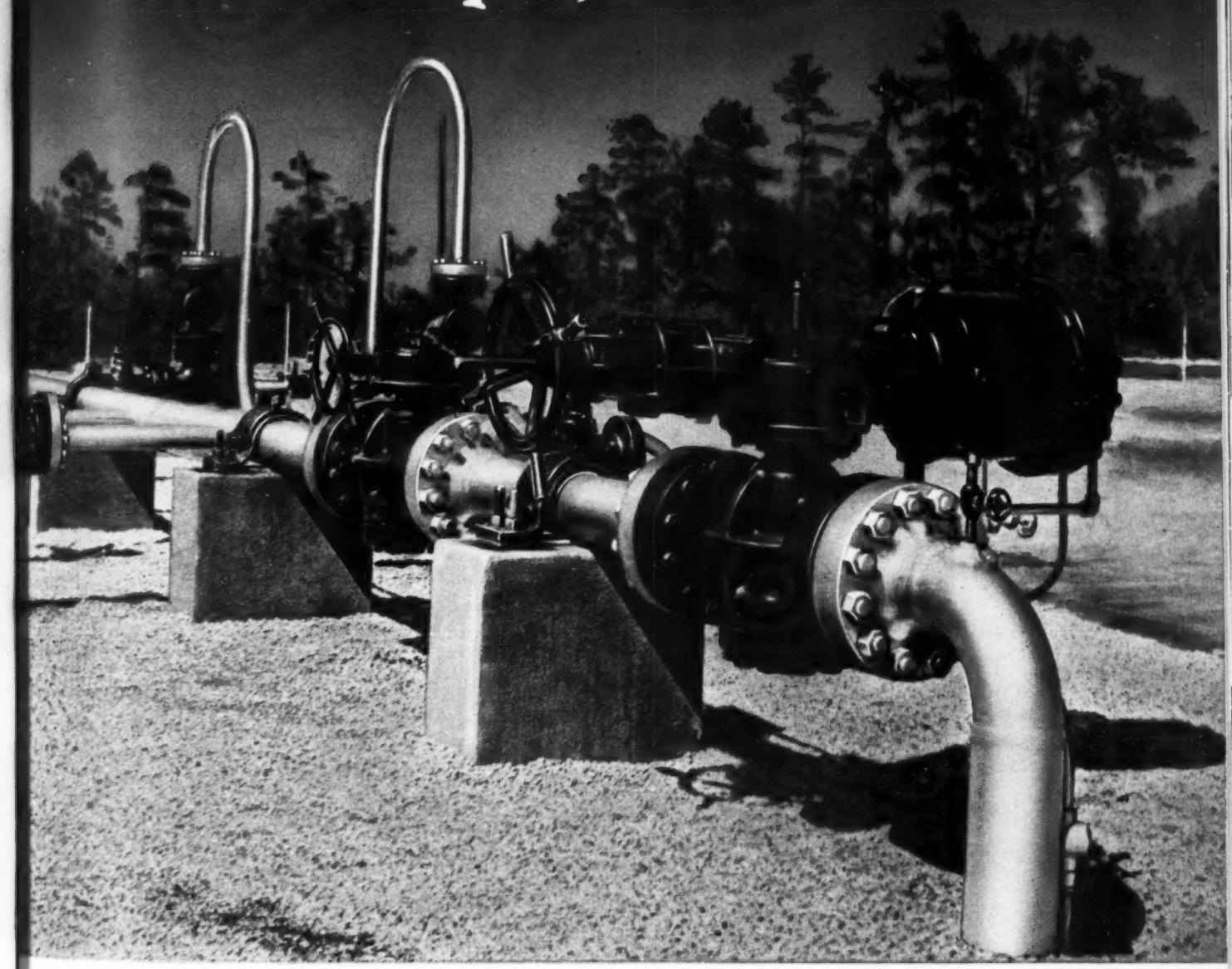

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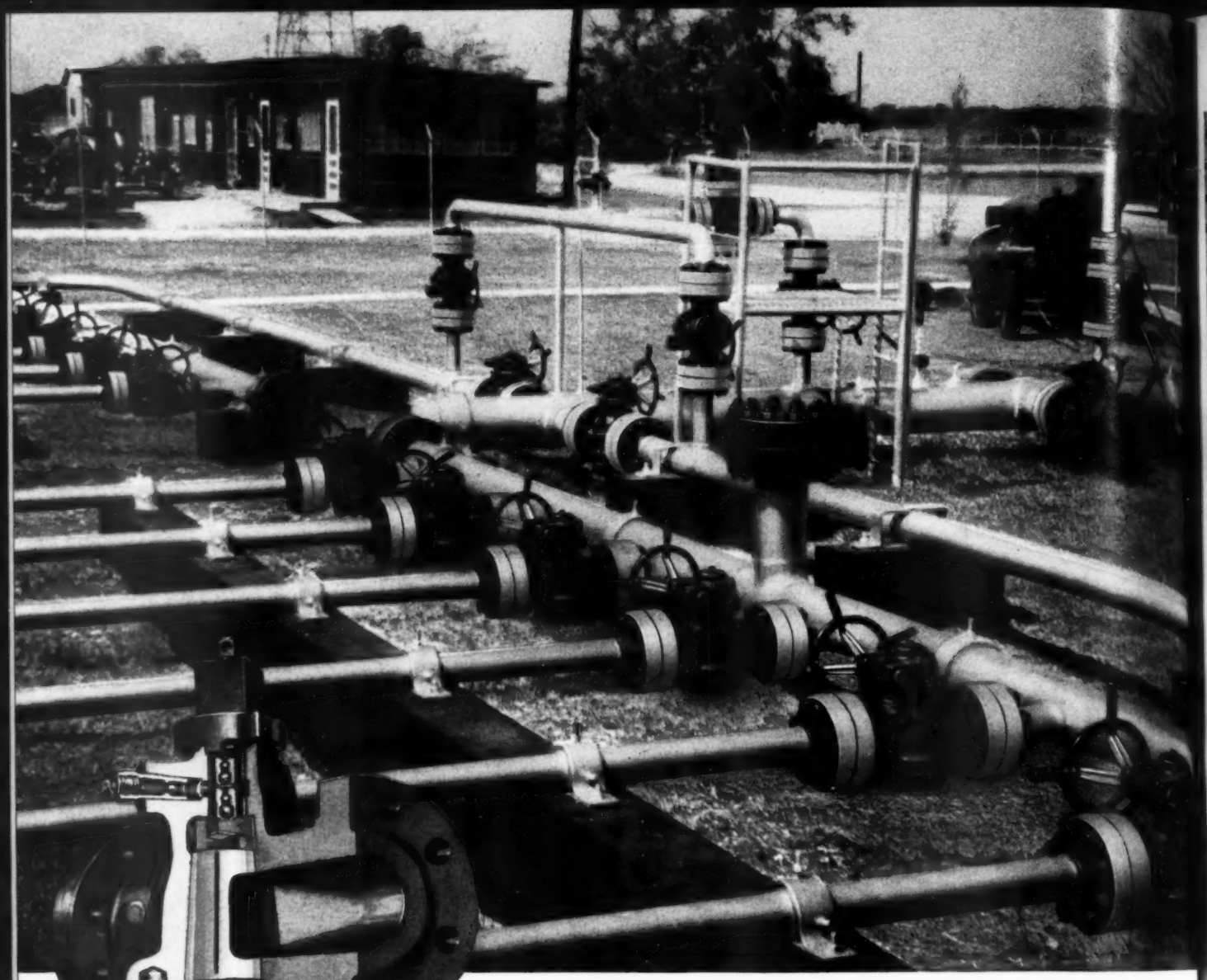

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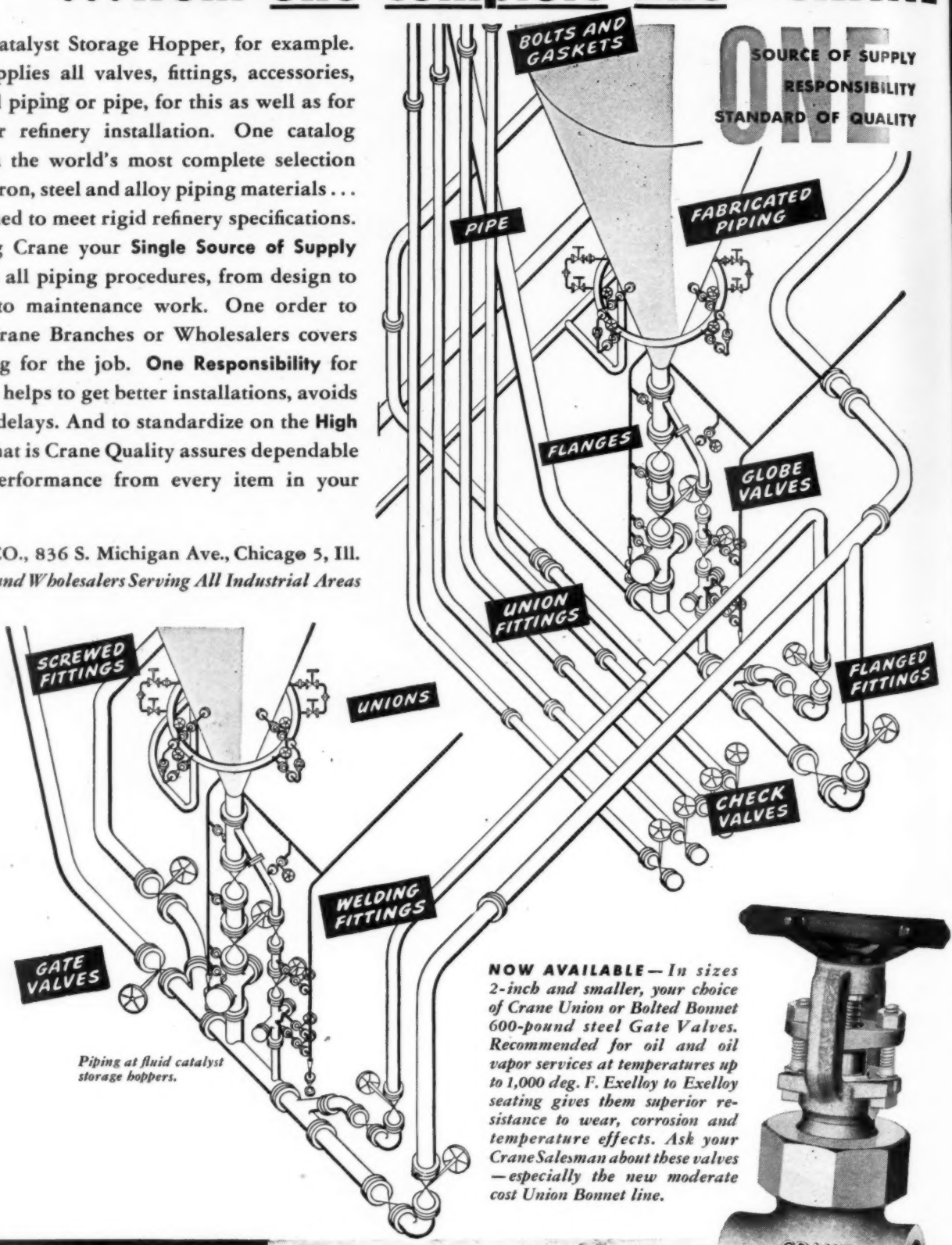

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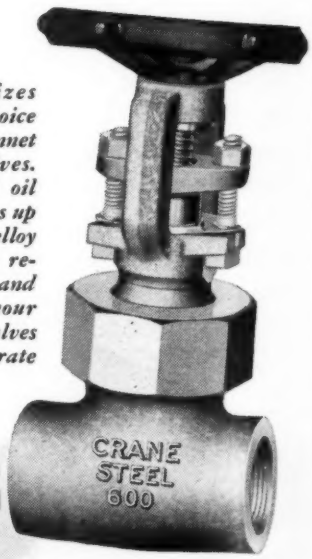

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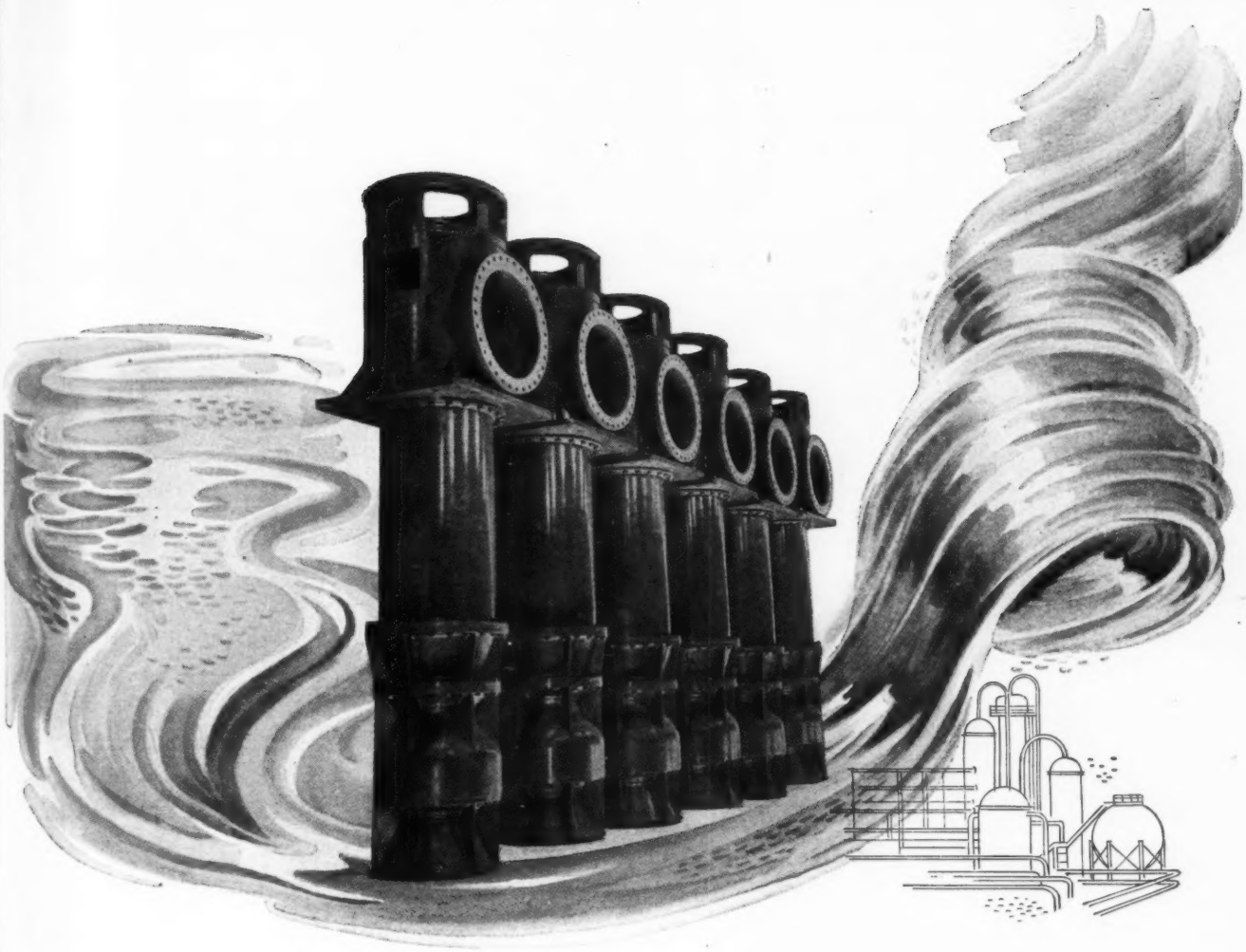

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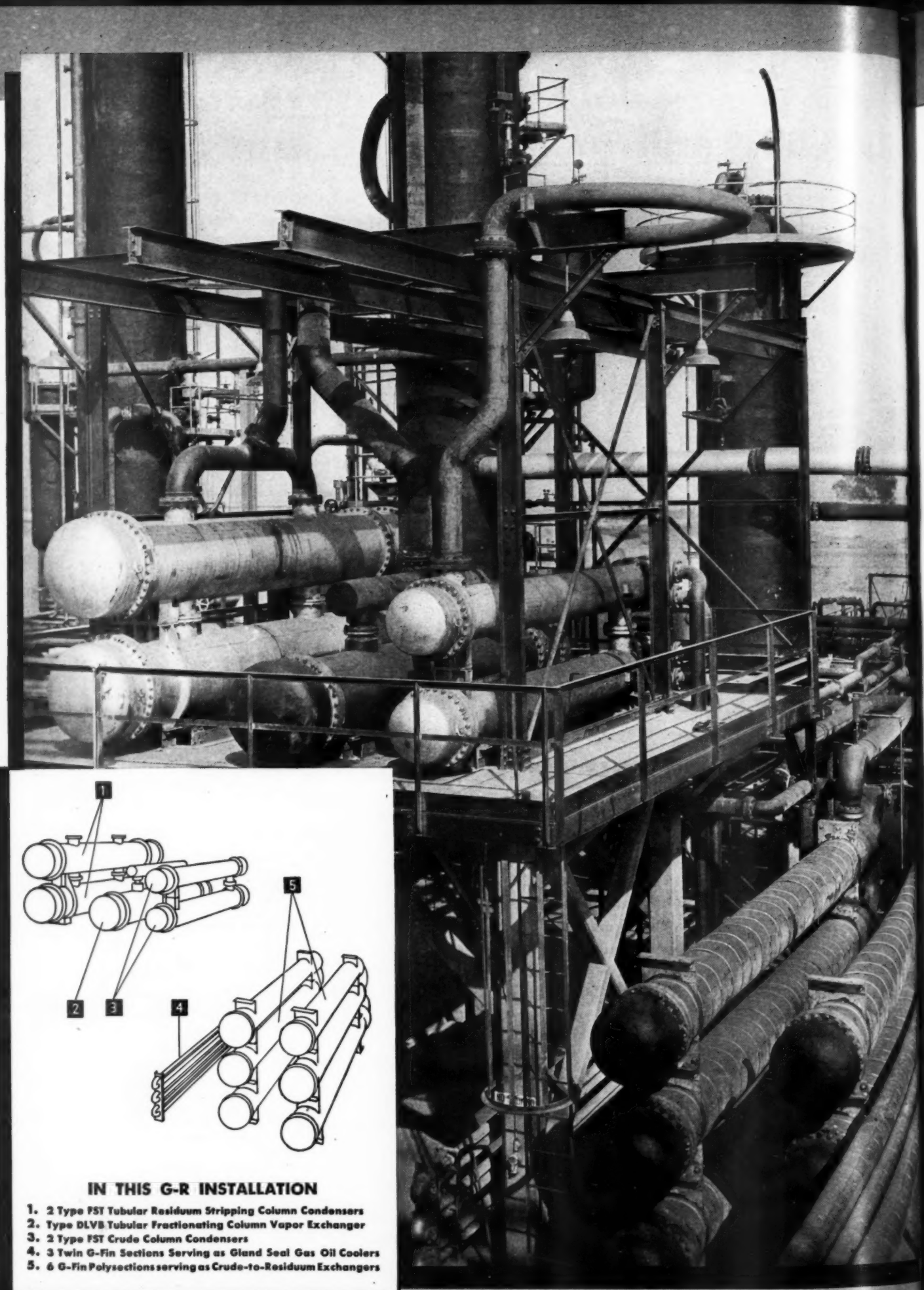

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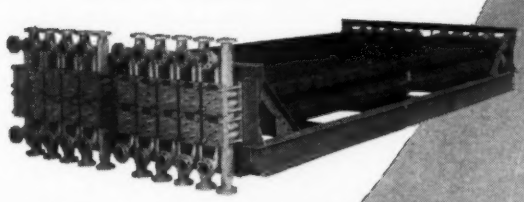

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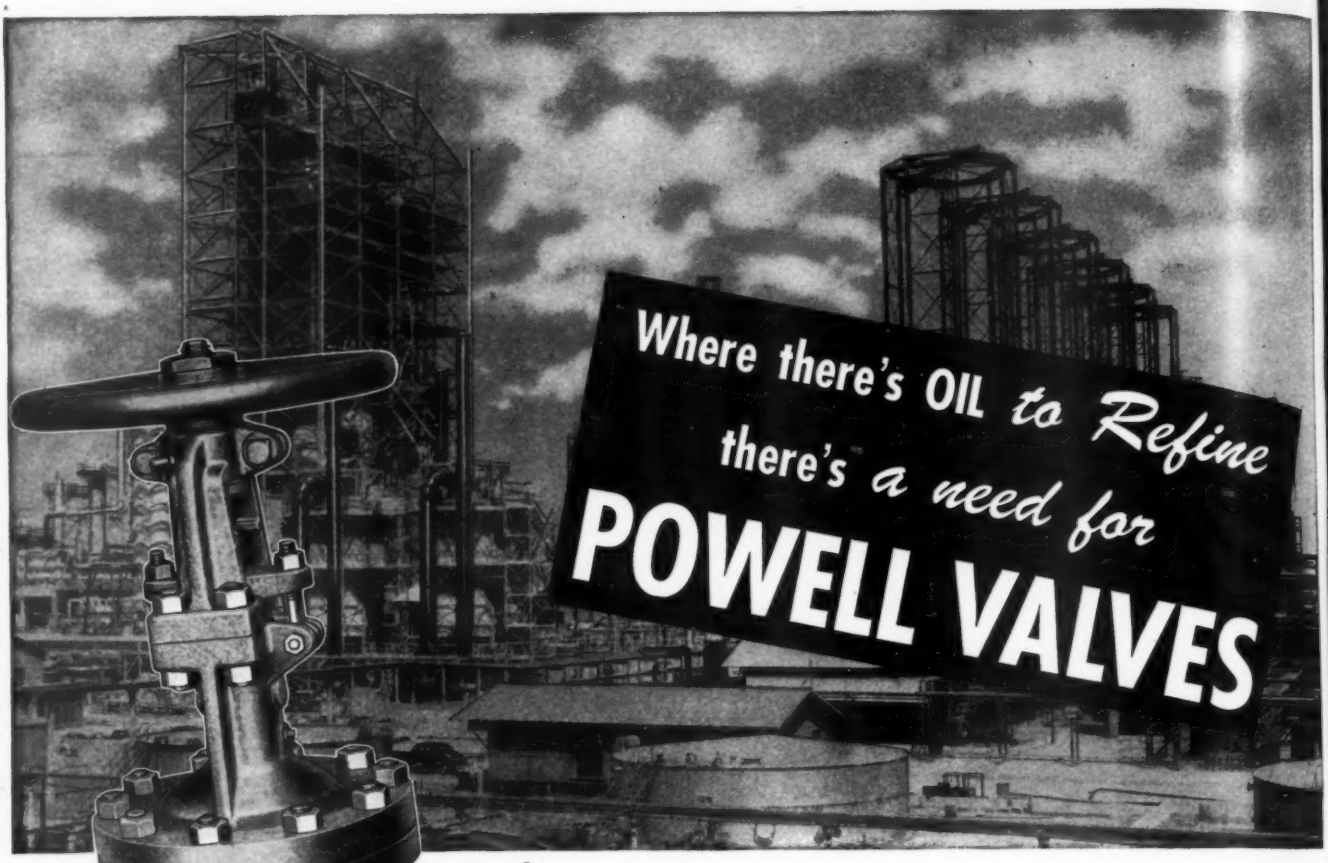

Fig. 3003—Class 300 Pound Cast Steel Gate Valve.

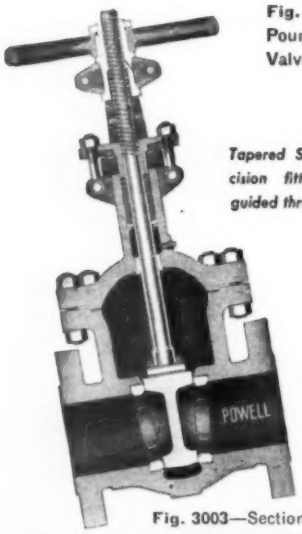

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Fig. 3003—Sectional.

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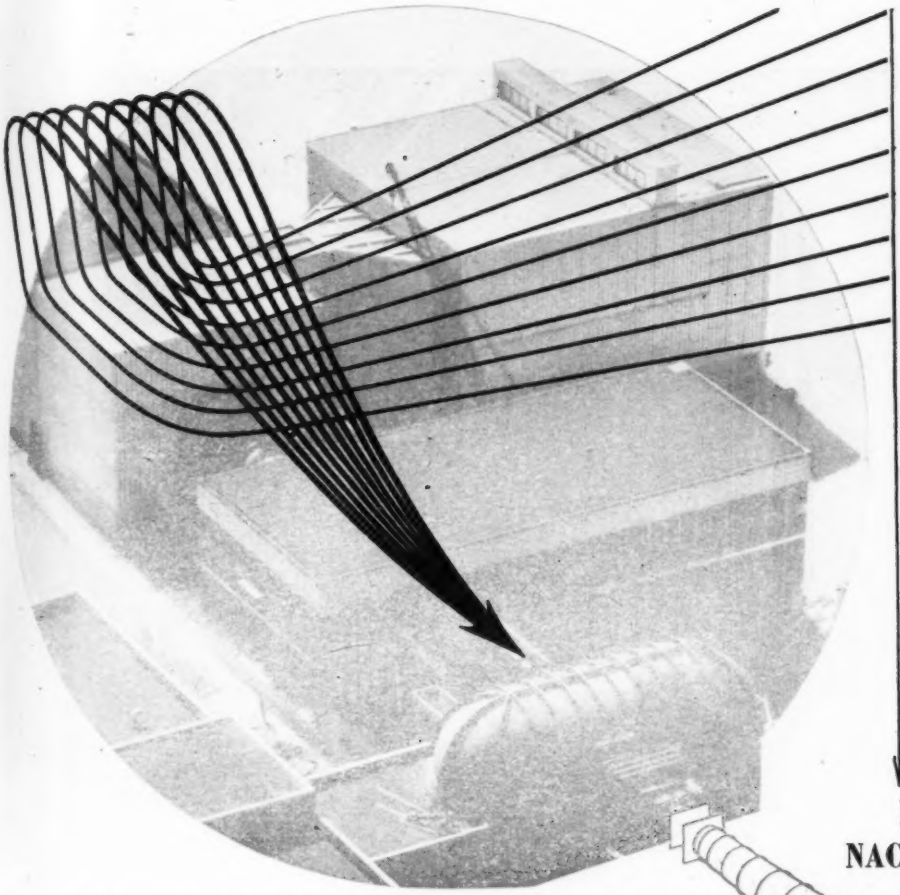


The National Advisory Committee for Aeronautics' giant supersonic wind tunnel. Photo, taken before the enclosure was completed, shows the huge conical diffuser through which air is discharged.

Drying 2,200,000 cubic feet of air per minute

How Activated Alumina helps NACA attain supersonic air speeds in a simulated stratosphere

Supersonic speeds nearly twice the speed of sound—and stratospheric conditions normally met at 35,000 feet *up*—are now brought down to earth in the world's largest supersonic wind tunnel at Cleveland, Ohio.

To simulate supersonic speeds at 35,000 feet of altitude, as much as 2,200,000 cubic feet of air, *per minute*, must be blown through the titanic "horn" at the newest NACA aeronautical research laboratory. But this air also must be dried to a *minus* 10°F. dew point before it is passed through the test section of the tunnel—a problem heretofore never considered for such a huge quantity of air.

To obtain this dryness, the air is passed through gigantic beds of ALCOA Activated Alumina where moisture can be removed at the rate of *240 gallons of water per minute!*

Activated Alumina is suitable as the drying agent, because it can be relied upon to maintain its form and properties even after an almost unlimited number of regeneration cycles . . . because it is chemically inert, non-toxic and does not swell, soften or disintegrate even when immersed in water. Then too, ALCOA Activated Alumina is available in the enormous quantities required.

Besides aiding research, ALCOA Activated Alumina also helps manufacturers make better products through reliable and efficient dehydration of liquids, vapors and gases. Its desiccating properties are used in the chemical, food, pharmaceutical and petroleum industries, in air conditioning and for the maintenance of oils.

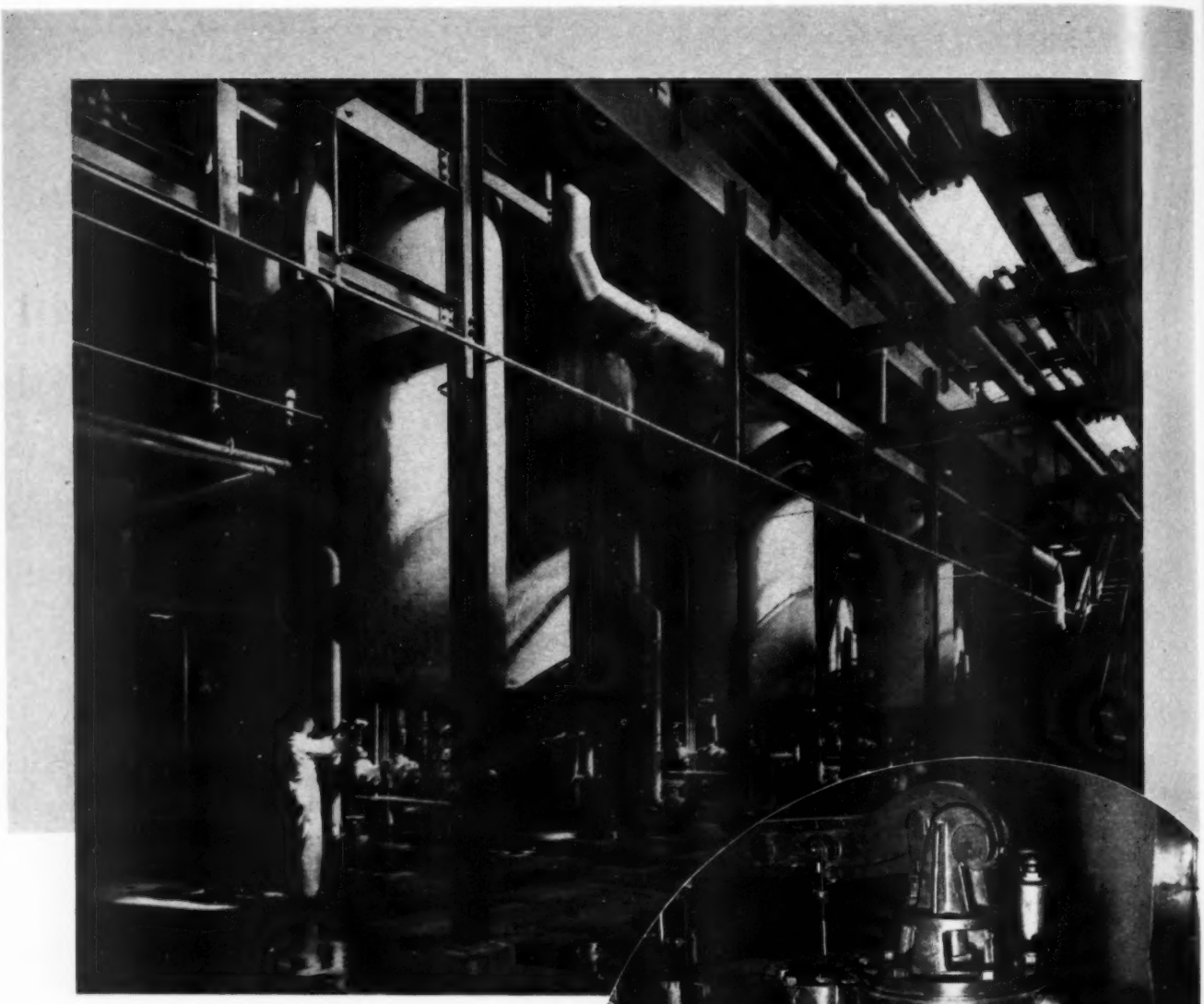
If you have a drying problem, it will pay you to investigate ALCOA Activated Alumina. Write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 1780J Gulf Building, Pittsburgh 19, Pa.

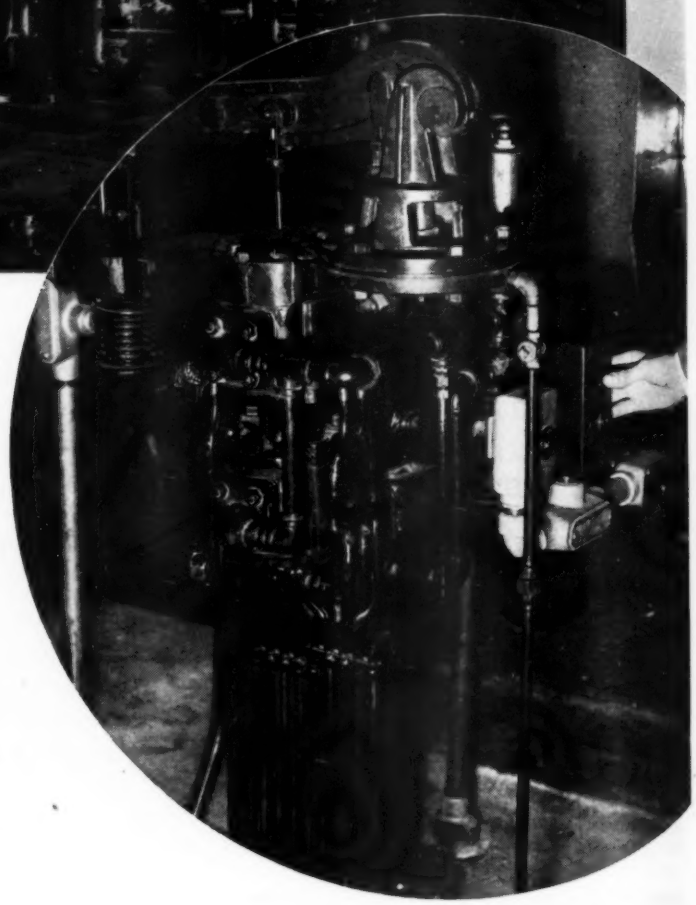
ALCOA CHEMICALS

ALUMINAS AND FLUORIDES

ACTIVATED ALUMINAS • CALCINED ALUMINAS • LOW SODA ALUMINAS • TABULAR ALUMINAS • HYDRATED ALUMINAS

ALUMINUM FLUORIDE • SODIUM FLUORIDE • SODIUM ACID FLUORIDE • FLUOBORIC ACID • CRYOLITE





A client contemplating new construction frequently knows the fundamental process scheme. The client's knowledge of his basic process is then complemented by Badger's broad experience in the design and efficient construction of plants using similar types of processes in allied industries. This teamwork has produced plants giving maximum dependability of operation with minimum operating costs. It may represent the approach to your next project.

PROCESS ENGINEERS and CONSTRUCTORS for the

COMPLEMENTARY TEAMWORK . . .

In many cases the client's knowledge of the details of a specific problem, plus Badger's ability to engineer and construct facilities to produce the desired results, form an ideal team.

E. B. BADGER & SONS CO. Est. 1891

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CHEMICAL, PETROLEUM and PETRO-CHEMICAL INDUSTRIES

FOR

FLAMMABLE LIQUID AND GAS FIRES....

...WHEN DISASTER THREATENS..

PIONEERS OF DRY CHEMICAL
ANSUL
REG. U.S. PAT. OFF.
FIRE EXTINGUISHING EQUIPMENT

DRY CHEMICAL FIRE TRUCKS

Get the facts. Send for your copy of specifications and copy of File No. 414. You'll also receive our latest literature with comparative rating charts for the various types of fire extinguishers.

...YOUR BEST PROTECTION

In the event of a fire emergency — not minutes — but FRACTIONS OF SECONDS, count. And the split-second fire stopping power of Ansul Dry Chemical can turn a headline disaster into a routine operation.

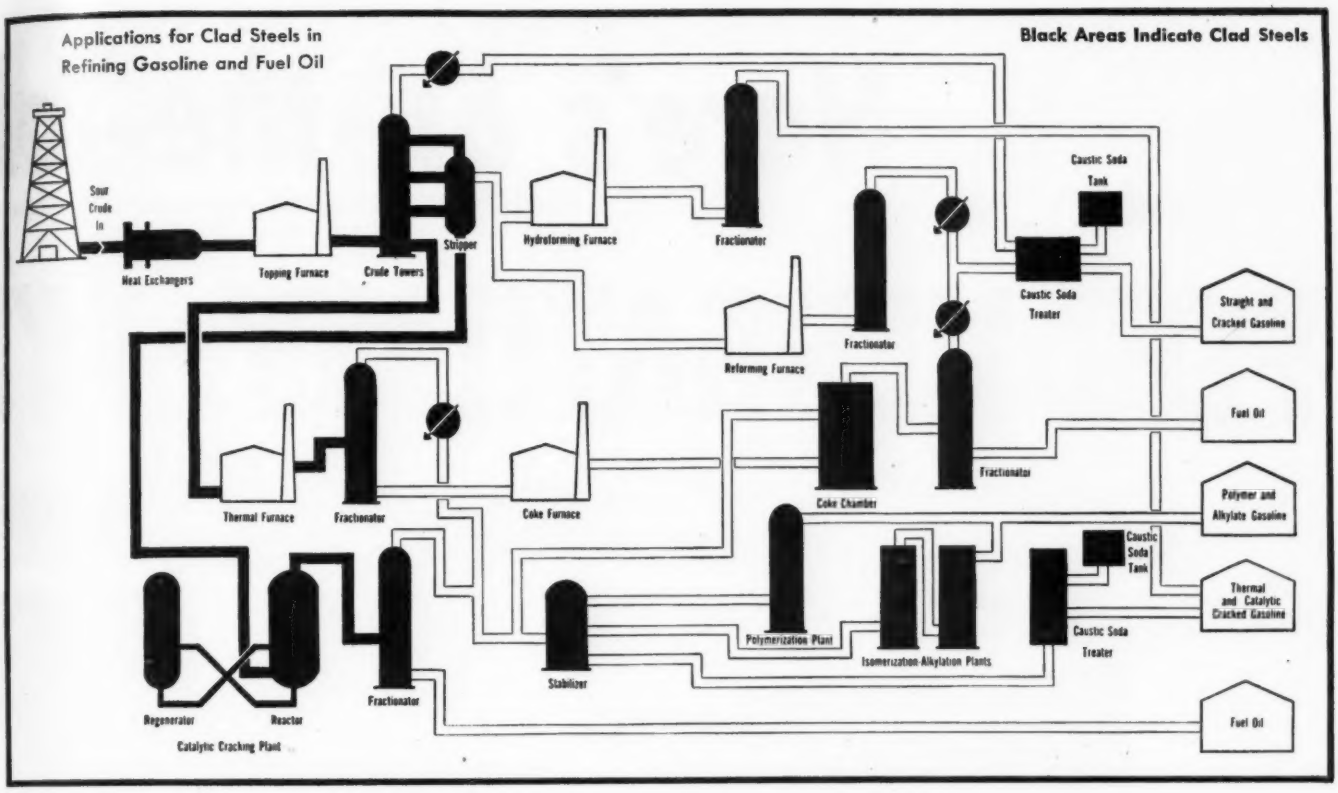
The Ansul Dry Chemical Fire Truck is a product of combined chemical and engineering research. The greater effectiveness of Ansul Fire Extinguishing Equipment, on flammable liquid fires, has been established by repeated tests conducted by nationally recognized approval laboratories . . . and proved conclusively by the broad preference for Ansul Fire Extinguishers on the part of the Petroleum Industry.

Regardless of your present equipment... type or quantity . . . an Ansul Dry Chemical Fire Truck provides the FASTER FIRE-STOPPING POWER you need during the critical seconds when disaster is in the balance.

ANSUL CHEMICAL COMPANY

FIRE EXTINGUISHER DIVISION, MARINETTE, WISCONSIN

DISTRIBUTORS IN PRINCIPAL CITIES IN THE UNITED STATES, CANADA, AND OTHER COUNTRIES



"Down time is so costly we use CLAD STEELS to avoid it"

"With the crude situation getting worse—more sour, more salty—we're making the investment now as a guard against trouble in the future. We never know when we'll have to process high sulfur crudes"; a prominent refinery superintendent's reason for using Lukens Clad Steels.

Nickel offers the protection required at one point in the process, whereas stainless steel, Inconel or Monel may be better on other jobs. On-stream service tests tell the story. Lukens Nickel-Clad, Stainless-Clad, Inconel-Clad and Monel-Clad Steels provide this *solid* metal protection with the economies offered by *clad* steels. Claddings 5% to 50% of total plate thickness are available as required.

In Lukens Clad Steels—the most complete range available from any source—a uniform thickness of the corrosion-resistant metal is permanently bonded to an ASME quality steel backing plate. Sizes run up to 178 inches wide or to over 3 inches thick.

Bulletin No. 461 discusses and shows applications of Clad Steels in the Petroleum Industry. For a copy, write Lukens Steel Company, 443 Lukens Bldg., Coatesville, Penna.

CLAD METAL STEEL

LUKENS

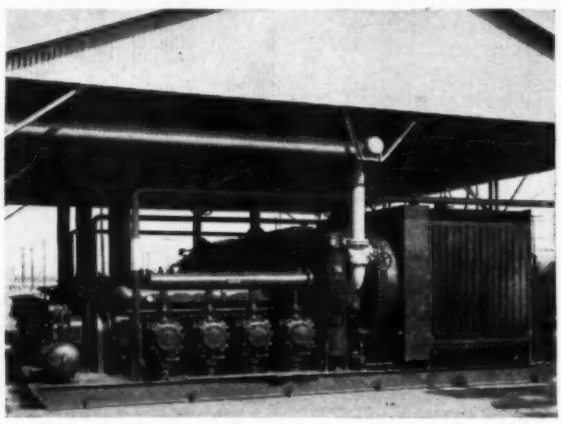
Nickel-Clad Stainless-Clad
Inconel-Clad Monel-Clad
STEELS

SOLID METAL ADVANTAGES WITH CLAD STEEL ECONOMY

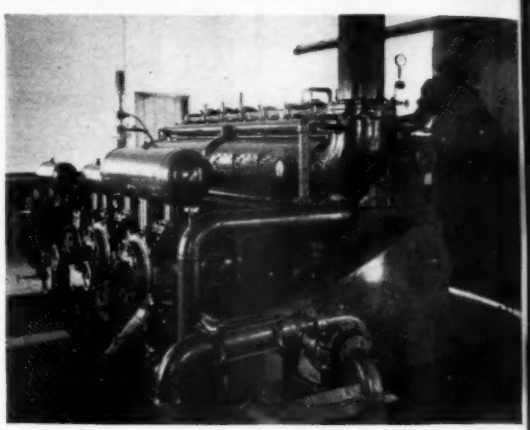
Here's on-the-job

FOR VERSATILITY...IT'S

GAS BOOSTER SERVICE

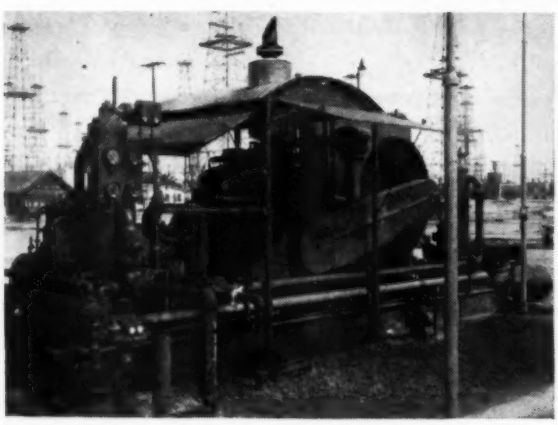


Three Clark Midget Angle 4-cylinder units, used for gas booster service at the Pacific Lighting Corporation, Wilmington, Cal.

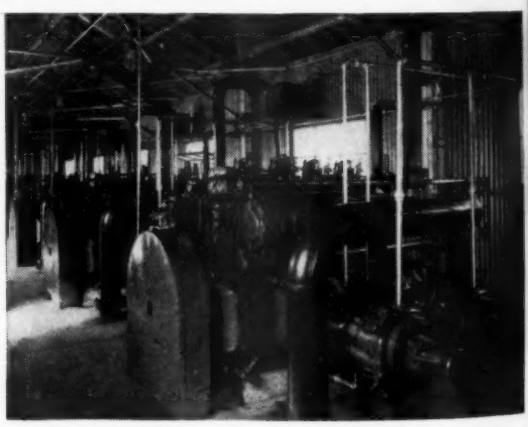


Clark Midget Angle 8-cylinder stationary units, used by the Union Oil Co., Lompoc, Cal., for gas booster service.

GATHERING FIELD GAS



Skid-mounted Midget Angle used for gathering field gas by Long Beach Oil Development, Long Beach, Cal.



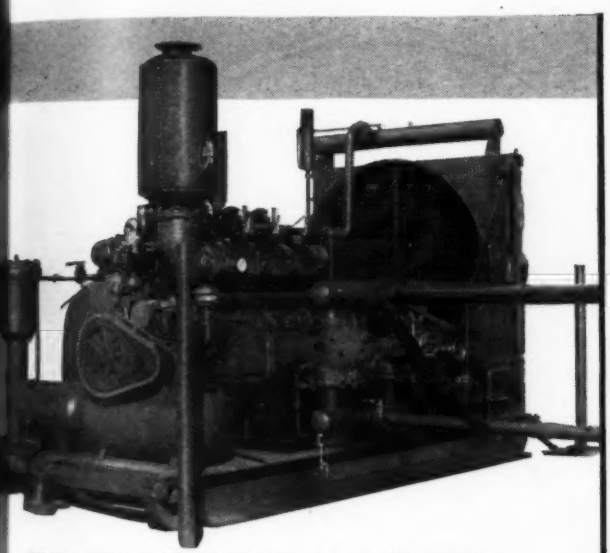
Five stationary-mounted 4-cylinder Midget Angles at Consolidated Gas Utilities Company, Magic City, Texas.

CLARK "MIDGET

ONE OF THE DRESSER INDUSTRIES

Proof!

THE "MIDGET ANGLE"



El Paso Natural Gas Company uses this Clark 4-cylinder semiportable MA unit for gas booster service at Jal, N. M.

These typical installations . . . only a few of hundreds throughout the industry . . . *prove* the versatility of Clark Gas-Engine-Driven "Midget Angle" Compressors.

For permanent installations, the "Midget Angle" cuts costs by occupying small floor space with light foundations. Mounted on skids, it is an ideal semiportable "packaged" compressor for short-duration jobs in the field.

Operating costs are low. Operation is practically automatic—one or two men can easily handle several stations.

Clark "Midget Angles" are available in 2, 4, 6 and 8 cylinder units, developing from 75 to 300 B.H.P. For further information call your nearest Clark Bros. office, or write for descriptive booklet.

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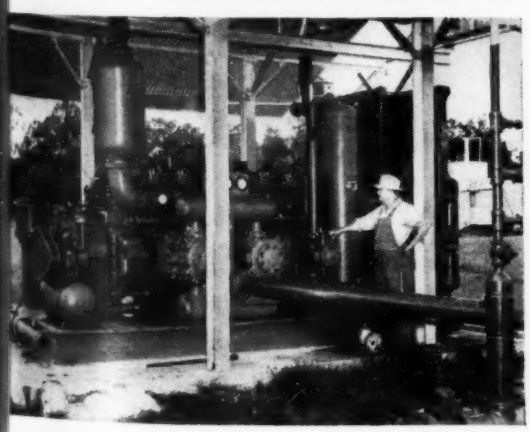
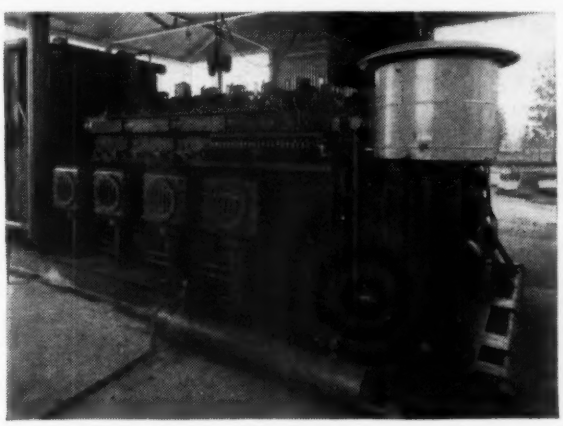
GAS LIFT



Skid-mounted Clark Midget Angle in gas lift service for the Atlantic Refining Co., Harden Field, Texas.

REPRESSURING



Two 8-cylinder Midget Angles used in repressuring residue gas back into producing sands—W. T. Burton Co., Stark, La.

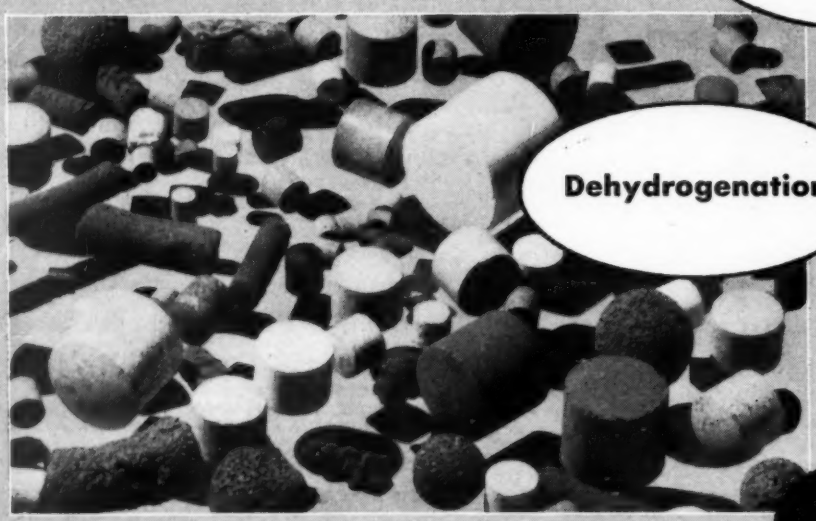
"ANGLE" COMPRESSORS

Harshaw

PREFORMED CATALYSTS AND CATALYTIC CHEMICALS

for Cyclization

Hydroforming



Oxidation

Dehydrogenation

Hydrogenation

Dehydration

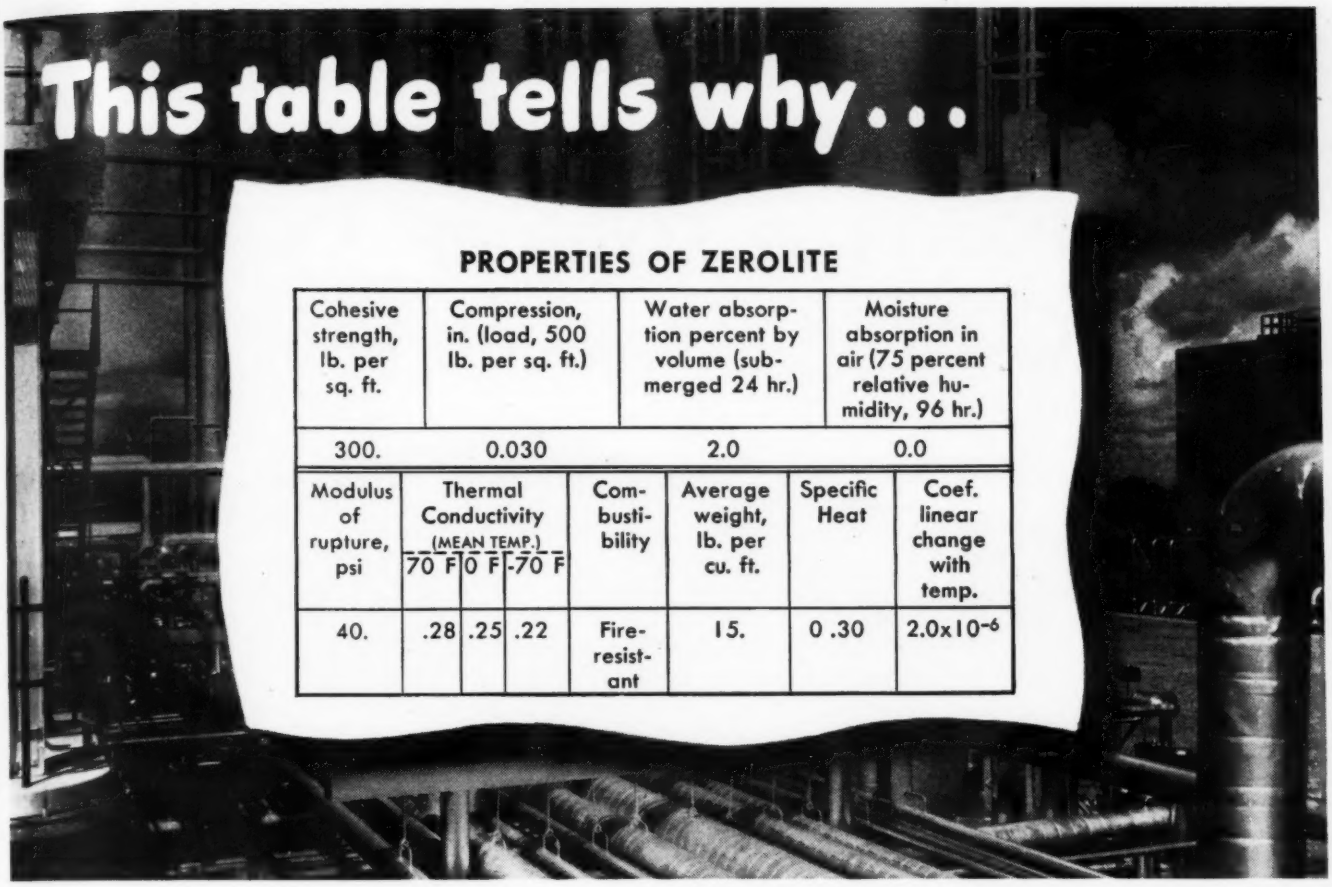
Alkylation

Desulphurization

Isomerization

There is an ever-increasing demand for Harshaw preformed catalysts and catalytic chemicals. Newly developed processes use and find Harshaw catalytic materials extremely dependable. Harshaw not only has a wide practical knowledge of how preformed catalysts and catalytic chemicals are used but also has a large capacity for their manufacture . . . to your specifications if you wish. We will be glad to discuss your catalyst problem with you.

THE HARSHAW CHEMICAL CO.
1945 East 97th Street, Cleveland 6, Ohio
BRANCHES IN PRINCIPAL CITIES



This table tells why...

PROPERTIES OF ZEROLITE

Cohesive strength, lb. per sq. ft.	Compression, in. (load, 500 lb. per sq. ft.)	Water absorption percent by volume (submerged 24 hr.)	Moisture absorption in air (75 percent relative humidity, 96 hr.)
300.	0.030	2.0	0.0

Modulus of rupture, psi	Thermal Conductivity (MEAN TEMP.) 70 F	0 F	-70 F	Combustibility	Average weight, lb. per cu. ft.	Specific Heat	Coef. linear change with temp.
40.	.28	.25	.22	Fire-resistant	15.	0 .30	2.0×10^{-6}

ZEROLITE is the outstanding cold insulation for use to minus 400F

IF you're checking specifications on insulations for a new refinery or chemical plant, take a good look at what Zerolite* Refrigeration Insulation has to offer:

Moisture absorption in air: 0.0; Combustibility: fire-resistant; Thermal conductivity at 70F: .28; Resistance to chemical damage: immune to attack by most organic solvents such as benzol, methyl ethyl ketone, and petroleum fractions and derivatives.

... Just a few reasons why Zerolite is considered by so many to be today's *outstanding* refrigeration insulation for industrial use. There are other reasons you ought to know more about, too ... and especially so if you are considering an insulation for any of the uses listed here ...

Zerolite is made from mineral wool processed with a special resin binder to make it exceptionally resistant to moisture and chemicals. It is available in sheet, lagging and pipe insulation form ... in a variety of sizes and thicknesses. The pipe insulations are further protected with an asphalt-saturated asbestos felt that reduces the need for seam filling and speeds installation.

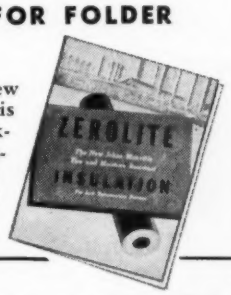
*Reg. U. S. Pat. Off.

ZEROLITE IS RECOMMENDED FOR:

- Petroleum dewaxing equipment
- Gas purifiers and condensers
- Chillers and exchangers
- Chemical process lines
- Pharmaceutical process equipment
- Reactors and economizers
- Solvent storage and piping
- Ammonia lines
- Cold tanks and vessels
- Freon lines
- Air conditioning equipment

SEND FOR FOLDER

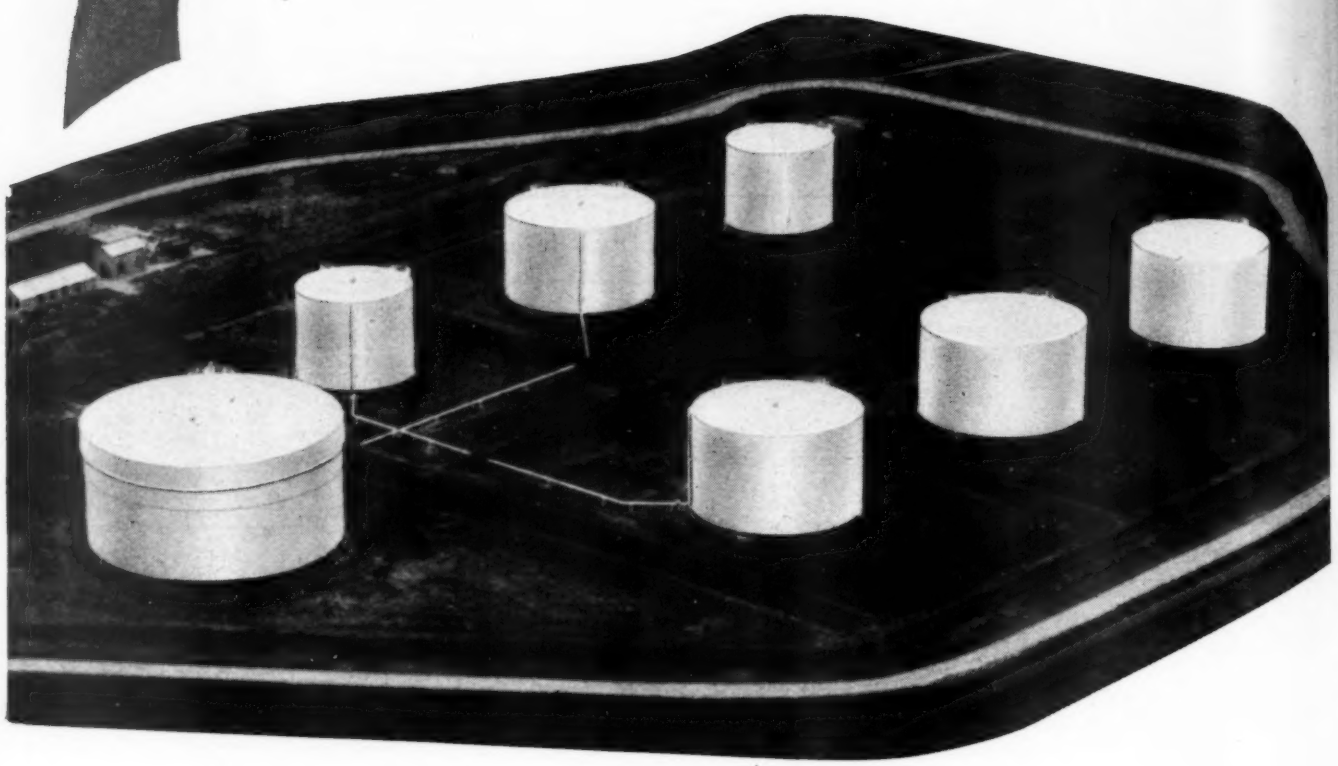
A copy of this new Zerolite folder is yours for the asking. Write Johns-Manville, Box 290, New York 16, New York.



Johns-Manville ZEROLITE

REFRIGERATION INSULATION

7 POINTS IN FAVOR OF GRAVER EXPANSION ROOF TANKS



Make a point-by-point comparison and you will be convinced that the Graver Expansion Roof Tank is ahead on any score. For example:

■ ***Positive Action*** . . . Patented design permits roof to rise or descend in a straight up and down motion as vapors expand or contract.

■ ***Tank Settlement*** . . . All tanks settle—but the normal unequal settlement will not affect the operation of the Graver Expansion Roof.

■ ***Stabilizer*** . . . Exclusive Graver feature assures peak operating efficiency even with an unbalanced load.

■ ***Maintenance*** . . . Lowest cost—less than any other tank designed for this type of service!

■ ***Liquid Seal*** . . . Protected liquid seal prevents escape of valuable vapors. Nothing to dope or patch; nothing to break, tear, or wear out.

■ ***Gauging*** . . . Because of the straight up and down motion of the Graver roof, gauging of the tank always takes place at the same point and accuracy is assured.

■ ***Multiple Installation*** . . . Where more than one Graver Expansion Roof is required in the same system, the full capacity of every one can be used. No vapors vented till *all* roofs reach full height.

Now . . . get the whole story. Make sure you are familiar with every feature of the Graver Expansion Roof Tank. Ask for full details today.

GRAVER

FABRICATED PLATE DIVISION

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

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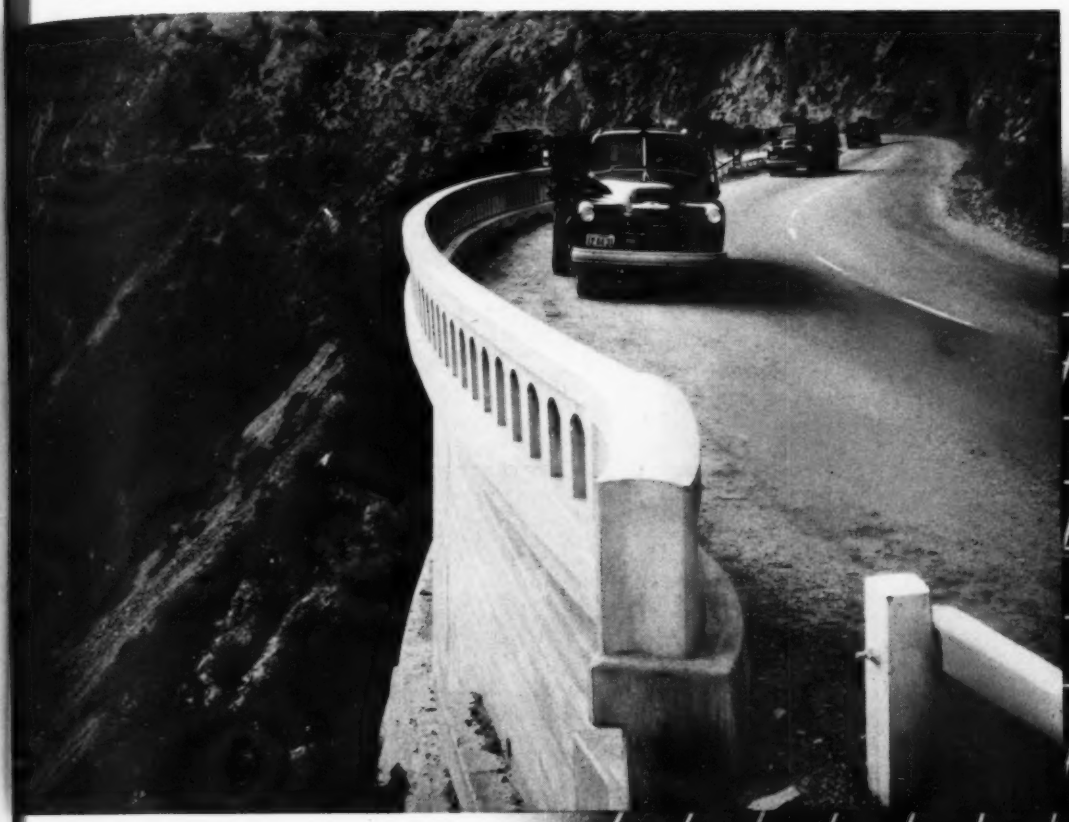
DUPONT TETRAETHYL LEAD COMPOUNDS



Test courses for the West Coast truck fleet cover all types of terrain.

Du Pont Research

at Work on Fuel Variables Affecting Engine Performance

It is well recognized there are a large number of fuel variables that affect engine performance. While much can be learned about these through laboratory research . . . it is necessary to supplement this information through carefully controlled research on the road.

As a part of its Petroleum Chemicals research program, Du Pont is conducting an intensive investigation of the effects of tetraethyl lead compounds and other fuel additives under all types of service conditions. Fleets of passenger cars, running under medium duty conditions, operate out of the East Coast Road Testing Laboratory at Deepwater, New Jersey, while heavy duty truck tests are conducted from the El Monte, California, Laboratory.

The test results, being obtained in these cars and trucks, are used as a guide in research on fuels and additives to assist the petroleum industry in the production of improved fuels which in turn benefit the motorist.

Engine adjustments are carefully made to insure uniformity of performance.

DU PONT
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BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Test trucks are operated in groups to provide comparative results.

Tractor units are carefully serviced to maintain peak operating efficiency.

When a test is completed, each engine part is carefully examined to determine the effect, good or bad, of additives under investigation.

West Coast Provides Heavy Duty Truck Tests

The Du Pont West Coast Road Testing Laboratory is the "heavy duty" test center. Here, tests simulating heavy duty truck service are conducted over terrain ranging from flat desert country to steep mountain grades making it possible to duplicate the wide variations in operating conditions encountered in service.

Equipment and courses are standardized; in addition, all of the trucks are operated simultaneously as a group to eliminate the variables of terrain, weather, traffic, etc. In this way tests are under rigid control and comparative and reproducible results are obtained.

Day and night this test fleet is piling up mileage investigating fuels and additives and the other variables affecting fuel performance. These heavy duty tests represent one extreme of operating conditions and are part of a long-range program investigating additive requirements for today and for the future.

MAKE DU PONT THE SOURCE FOR ALL OF YOUR GASOLINE ADDITIVES . . .

Tetraethyl Lead Compounds
(Motor Mix—Aviation Mix)
Antioxidants
Metal Deactivator—Dyes

DU PONT
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tter Things for Better Living . . . *Through Chemistry*

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ETROLEUM CHEMICALS DIVISION
Wilmington 98, Delaware

District Laboratories: Wilmington, Del. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · El Monte, Calif.

District Offices: Wilmington, Del. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · Los Angeles, Calif.

A flange broken 50 years ago...

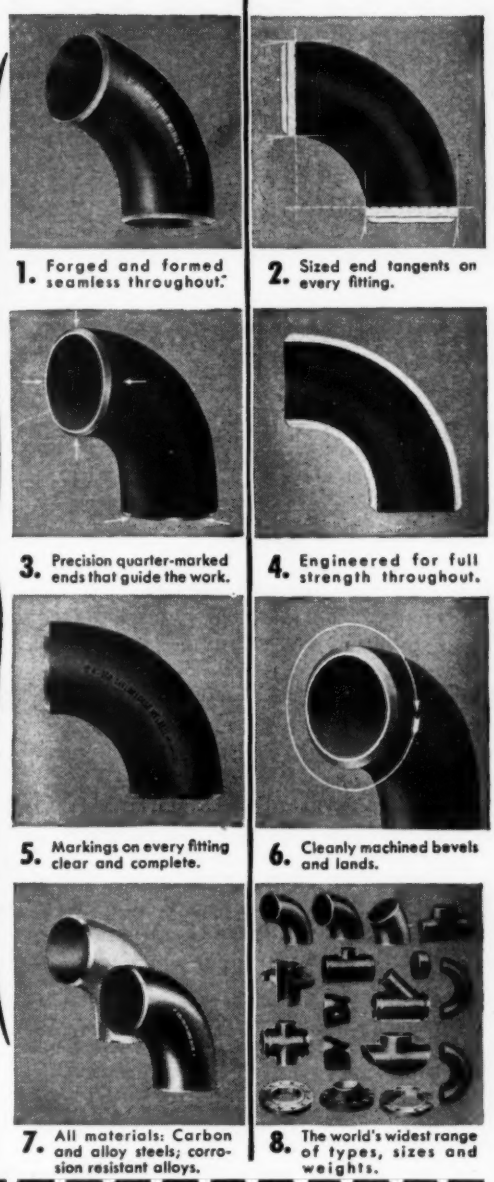
...led to one thing, to another, to another...

When Taylor Forge started up, way back, with spiral pipe it was our No. 1 item (still important). In those days cast iron flanges were largely used, and the troubles resulting from flange breakage were frequent and aggravating. The remedy for this major headache was found in the development of forged steel flanges; first for our own spiral pipe, later for our straight seam, and in fact any pipe; finally for general pressure vessel and industrial application.

That put us definitely in the forging business some forty years ago and was the start of a long pioneering journey into the field of engineered piping problems. The expanding needs of industry multiplied the response for larger, heavier, stronger, and tougher flange and ring forgings to which we reacted with new, heavier, and numerous units of forge, press, and rolling equipment. It was equally necessary to pioneer design methods, not only for flanges and pipe application, but for other pressure vessel components as well—so that almost automatically we became, and remain, the world's largest manufacturer of forged (or forge-rolled) steel flanges, welding necks, manways and nozzles, etc., for *any* application.

Then came rapid strides in the art of welding which quickly cancelled out the crude, cut-fit-patch methods first attempted in pipe systems. Again we found it necessary to *engineer* the design of suitable components. Several years of research preceded the development of the *full,* engineered line of Taylor Forge welding fittings—the well-known WeldELL line. Examine the illustrations to the right, and note how many unique features combine good engineering with good sense and ultimate economy. The coupon below is the convenient means for getting more information about the fittings that have "Everything."

WeldELLS *have everything*



1. Forged and formed seamless throughout.
2. Sized end tangents on every fitting.
3. Precision quarter-marked ends that guide the work.
4. Engineered for full strength throughout.
5. Markings on every fitting clear and complete.
6. Cleanly machined bevels and lands.
7. All materials: Carbon and alloy steels; corrosion resistant alloys.
8. The world's widest range of types, sizes and weights.

TF TAYLOR FORGE

TAYLOR FORGE & PIPE WORKS General Offices & Works: Chicago 90, Ill. (P.O. Box 485). Eastern Plant: Carnegie, Pa. Western Plant: Fontana, Calif. • District Offices—New York: 50 Church Street • Philadelphia: Broad Street Station Bldg. • Pittsburgh: First National Bank Bldg. • Chicago District Sales: 208 S. LaSalle Street • Houston: City National Bank Bldg. • Los Angeles: Subv Terminal Bldg.

Please send a copy of your new catalog 484 covering welding fittings and forged steel flanges.

Name_____

Position_____

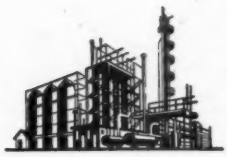
Company_____

Street address_____

City_____ Zone____ State_____

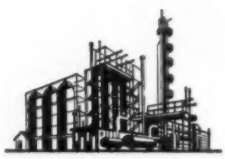
715-0949 Mail to Taylor Forge & Pipe Works, P.O. Box 485, Chicago 90, Ill.

REFINERS RELY ON McKEE...



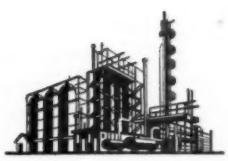
FOR SOUND DESIGN

Hundreds of successfully operating McKee-designed refineries all over the world prove the value of McKee design.



FOR EFFICIENT ENGINEERING

McKee's long experience and closely coordinated organization of well-qualified specialists assure the refiner efficient, economical engineering and procurement.



FOR PROMPT, ECONOMICAL CONSTRUCTION

McKee recognizes the importance of prompt, economical execution of contracts to transform capital investment into profitably operating plant in the shortest possible time.

ARTHUR G. McKEE & COMPANY

DESIGN, ENGINEERING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRIES

ENGINEERS AND CONTRACTORS • ESTABLISHED 1905
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TROLEUM
ROCESSING
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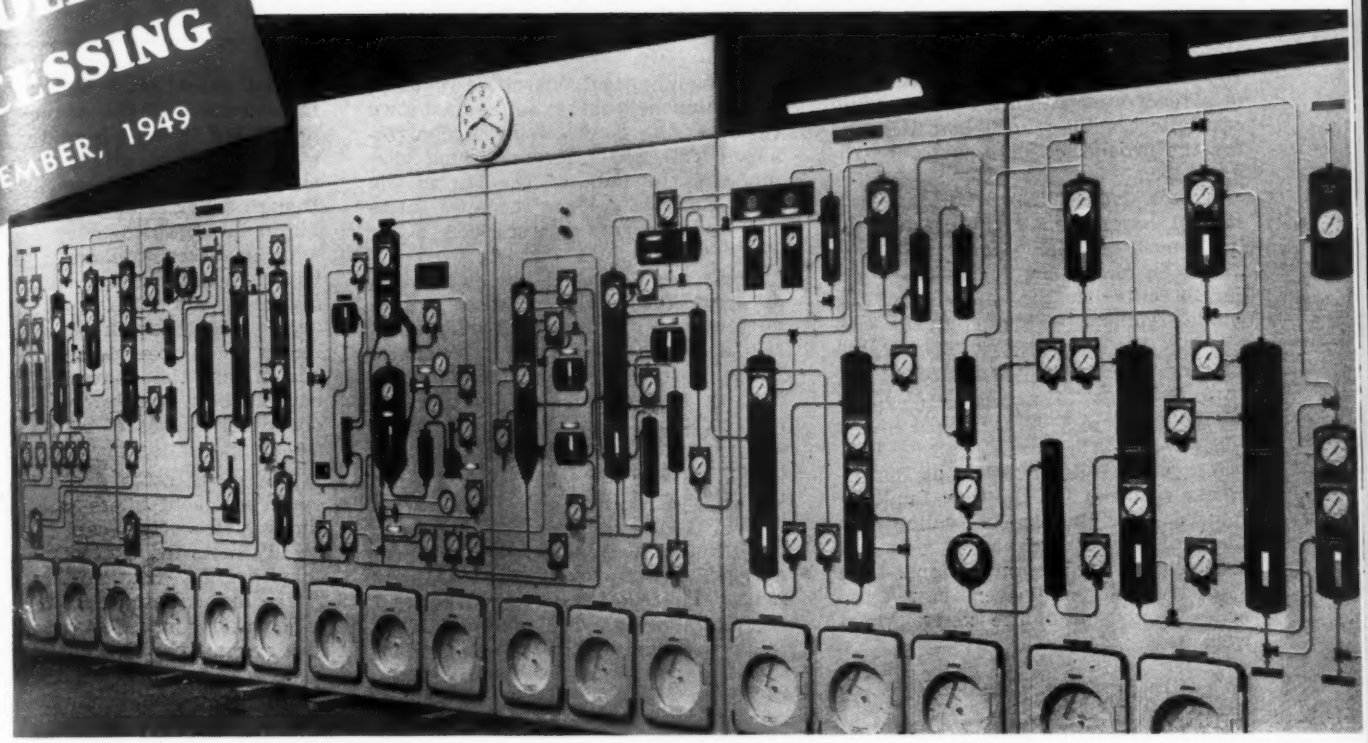

Six sections in one control board, covering six process units: left to right, crude stills, fluid catalytic cracking, fractionation, gas concentration, catalytic polymerization, and liquefied petroleum gas unit

One Instrument Panel Controls All Refinery Process Units

The instrumentation of petroleum refineries has passed through three distinct stages and now appears to be approaching a fourth. In the early days of batch shell stills, taking a sample and checking specific gravity was considered sufficient process control. As continuous operation entered the picture, boiling ranges became important for product quality, and thermometers and pressure gages became the chief form of control. This led to controlling instruments, motor-operated valves, and the like, which today are centralized on panels in control rooms or buildings at each process unit.

The fourth stage of development in refinery instrumentation is now seen as one simplified panel for the entire refinery, with a background comprising a simplified flow diagram of the complete plant —hence the name, "graphic panel." Several such panels are now being installed in refineries around the country. Developed by Universal Oil Products Co. and Panellit, Inc. the new panel is described in a paper "Process Control By Graphic Panel," by David M. Boyd, Jr., of UOP, and scheduled for delivery Sept. 14th at the Fourth National Instrument Conference and Exhibit in St. Louis. The following article comprises the principal portions of Mr. Boyd's paper.

By DAVID M. BOYD, Jr.
Universal Oil Products Co., Chicago

COMPLETE centralized control of processes for an entire petroleum refinery on one relatively small instrument panel.

This newest approach to the "push-button petroleum processing plant of tomorrow" has now become a reality with the installation of such a control board in the Indianapolis refinery of Rock Island Refining Co. as part of a recent overall plant expansion program.

Incorporating a simplified flow diagram of the complete refinery right on the panel itself, the board has indicators and control knobs placed directly on this diagram in positions corresponding to the actual units out in the plant. Recording instruments are located in a row along the bottom of the panel.

The installation is said to overcome several disadvantages of present-day conventional instrumentation: 1) control rooms are scattered over the plant, one on each processing unit, 2) panels often are huge and complex, using more instruments than are really needed.

Operational advantages cited for the Rock Island installation include: 1) all information is centralized in one room, 2) operator training is simplified through the fact that instruments are incorporated in a flow sheet of the plant, 3) the entire panel is small, only 25 ft. long, requiring a minimum of "legwork", 4) the transmission lag problem—over distances as great as 300 ft. at Rock Island—has been overcome. This lag was not too serious in temperature, gas, pressure, or some level control problems, but was found to give trouble on liquid flow control problems, especially where the mercuryless type of flow transmitters was used.

The Rock Island refinery originally operated a combined crude and thermal cracking unit, and had a gas concentration and poly unit connected with it. The new construction program called for a revamp of

the thermal cracking unit, addition of a feed preparation section, a Fluid catalytic cracking unit, and facilities for the production of liquefied petroleum gas.

It was desired to use the existing control room for all the new facilities, even though some of them would be about 300 ft. away, in order to centralize the operation of the whole refinery. This, coupled with the fact that mercuryless flow transmitters were to be used on the new unit, called for the consideration of pneumatic set, locally mounted controllers.

A check of the number of instruments required for the new facilities showed that the space available in the existing control room was not sufficient to hold a conventional type of instrument panel even though the whole north side of the control room were used.

Graphic Type Indicated

All these considerations seemed to point to the use of a new type of control system in which the controllers would be locally mounted and would require a minimum of board space. The graphic panel type of system seemed to hold promise with its smaller instruments and the pneumatic set controllers where required.

A rough design of a graphic panel was made and shown to the refiner. He agreed to try it out on his new unit because he felt it would have a distinct advantage in the training of operators on the handling of the new unit, as the flow sheet would be in front of them at all times. In addition, he felt the possibilities of an upset would be lessened.

One of the first points to be decided in the design of the panel was where to mount the controllers, since the field-mounted controllers required four runs of tubing as against two runs for the board-mounted controllers. The 300-ft transmission distance is the bulk of the lag in the flow control system, because mercuryless flow transmitters were being used.

Tests were carried out using two different force-balanced flow transmitters, two different controllers, and two different valves and positioners. These were used to control a small flow of water from a plant water line. Various lengths of tubing were used in the transmission and controller lines to give the effect of moving the controller to the control board.

With the installation, a direct relationship was found to exist between the throttling range required for stability and the distance from the controller to the process. The throttling range varied from 75% at 10 ft. to 500% at 300 ft. transmission distance. The reset rate setting was 0.2 minutes at 10 ft., which was the fastest reset rate obtainable at this time on conventional controllers. When the transmission distance reached 300 ft., the reset rate was 0.5 minutes.

All of these figures are interesting, but the main factor is the actual performance of the controllers at 10 and 300 ft. transmission distances. For a given upset, the area under the recovery curve of the controller at 300 ft. was a matter of 100 times greater than the area under the recovery curve at 10 ft.

The throttling range of the controller located at the 300-ft. distance could be reduced to any desired value by restricting the flow into the receiver element by means of a dampening device, but only at the sacrifice of reset rates and accuracy of measurement. The net control was not found to be materially improved by the addition of the restriction to the board-mounted controllers, even though a better apparent flow record might be obtained.

It is rather interesting to observe that none of the conventional, pneumatically-operated controllers that are in use today in oil refineries are really of a completely satisfactory design for the control of flow, because they are proportional band controllers instead of pure proportional speed floating action.

The reset rates available on conventional controllers are about 10 times slower than can be used with locally mounted controllers and mercuryless flow transmitters. Probably the main reason that the available proportional speed floating controllers are not used is that they are too bulky and expensive. A market appears for a small, simple, pre-engineered proportional speed floating controller, preferably one that could be mounted right on the control valve.

Complete Records Unnecessary

In designing the Rock Island panel, a considerable amount of thought was given to the question of which points to record. When the plant owner was consulted, he indicated that he was not interested in permanent records of all controllers, because these data are recorded on the operator's log sheet every hour or two, and the records are not consulted very often after they have been removed from the instrument, except for accounting purposes and to show temperature trends.

Five pneumatic recorders are provided, each of which contains four pens. This gives 20 recorder points in all for the 76 controllers and approximately 30 indicators that were used on this plant. These recorders are all 3 to 15 psi. receivers and are provided with snap couplings so that they can be plugged into any of the controllers or indicators on the board that the operator desires to record. The temperature transmitters used on the panel are of the recording type, so they give continuous records of temperature trends at all times.

In laying out the flow plan of the panel, every effort was made to keep it as simple as possible. Only major pieces of equipment and process flow lines are shown, such as towers, reactors, and heaters.

Acknowledgment

I wish to express my appreciation to Mr. L. E. Winkler of Rock Island Refining Co. for allowing us to use the data obtained in his plant, and to Mr. L. E. Stewart for his help in running the flow tests.

Features of Graphic Panel

The following brief description of the Rock Island panel has been furnished PETROLEUM PROCESSING by Panellit, Inc., co-developers with UOP of the panel:

1. The flow sheet comprises anodized aluminum symbols, and formed anodized aluminum strips for pipe lines (in seven colors): gold for oil, yellow for vapor, orange for recycle, blue for air, green for water, red for catalyst, silver for instrument lines.

2. Remote supervision of flows with controller located at the process unit — Moore Products M/P Station and Model 52 Controllers. (See PETROLEUM PROCESSING Jan., 1949, "What's New!" Item 16, p. 94.)

3. All instrumentation on the graphic section based upon new 3½-in., two pointer pneumatic receivers, making possible compactness and accuracy.

4. New illuminated dial vertical level indicator (pneumatic receiver) designed especially by Panellit, makes levels show up like a liquid column gage, directly on the tank symbol.

5. Alarm system, using translucent plates which light at the point of trouble (on the flow sheet) when the alarm horn sounds. Hermetically-sealed relay plug units interlock the alarm system with master horns, in the control room and out in the refinery.

6. Operator can stand in the center of the control room and see what is happening in all parts of the plant.

New Type Heavy-Duty Motor Oils Carry Up to 20% of Additive

By V. B. GUTHRIE
Editor, Petroleum Processing

THE new high additive content motor oils, developed since the war for extreme heavy-duty service conditions, are now coming into commercial use, in Diesel engines particularly, and in gasoline engines in some instances.

These oils are conventional highly refined petroleum lubricants, built up with larger proportions of additives than have before been used. As compared with a maximum of 4 to 6% of additive in oils meeting Army Ordnance Specification 2-104B, the two types of the new oils contain respectively 8 to 12% and 16 to 20% of additive.

In oil company parlance the new oils have been dubbed "high ash" because of their high ash value resulting from the volume of inorganic soluble material in the additives. In some instances the ash content is over 2.5%, as compared with about 0.2% in conventionally compounded heavy-duty oils. However, the ash does not promote abrasive wear, it is said, and tests to date show the deposit from this cause on spark plugs and engine parts to be no greater than with 2-104B oils.

Additives Aimed at Detergency

The new additives used are complex compounds of barium or other chemical substances, to give greater detergency than has previously been built into an oil. Included in them are oxidation inhibitors and specific compounds to neutralize the corrosion products of combustion which are a principal cause of engine wear.

The new oils, now made in the SAE 10 and SAE 30 grades, are recommended for severe engine operating conditions only. Here their higher cost may be offset by such factors as longer periods between oil change, saving in engine wear, longer time between engine overhauls and, with Diesel engines, the possible use of a lower grade fuel than where lubrication is with regular heavy-duty oils. For normal operating conditions regular heavy-duty oils are recommended.

Development work looking to new types of additives for crankcase oils, and the use of a larger proportion of additives, started on the West Coast during the war.

This was in an effort to overcome the difficulties encountered by Diesel engines in pumping service in irrigation projects, on ships of the tuna fleet, among other uses, where operating conditions were severe and too frequent engine overhauls were necessary where conventional heavy-duty oils were used. These difficulties were aggravated when high sulfur fuels were consumed. Caterpillar Tractor Co., among the equipment manufacturers, and some of the oil companies carried on intensive laboratory research programs supplemented by test programs in the field.

The new oils were commercially recognized in 1948, when Caterpillar Tractor Co. approved the high additive oils of the Shell Oil Co. Inc., and Standard Oil Co. of California as meeting its standards for what were called "Series 2" oils. The Texas Co. also carried on development work in this field at an early date. Tables 1 and 2 show typical properties of Shell Oil Co. and The Texas Co. new high-additive oils in SAE 10 and 30 grades.

Richfield Oil Corp., and Sinclair Refining Co., during the same period, were individually working experimentally with oils with an additive content intermediate between that of the conventional 2-104B oils and of the new type oils approved by Caterpillar Tractor Co. This intermediate high additive oil is now being made commercially by Richfield, Sinclair, and other oil companies, as well as oils meeting the Series 2 standards. The new oils have lately been recognized by the Army Ordnance Department, as Supplemental 1 (Intermediate) and Supplemental 2 (Series 2) to its approved 2-104-B Specification oils.. However, the Army is not purchasing oils from the supplemental lists at this time.

Among the oil companies, Shell Oil Co., Standard Oil Co. of California, and the Enjay Co. (Standard of New Jersey) are manufacturing the additives used in the new oils. Table 3 lists the properties of Enjay's detergent-inhibitor type for oils to meet 2-104B, Supplemental 1 and Supplemental 2 specifications. The additives are also made by the Lubrizol Corp.

The results to date of the use of both types of high additive oils have been pronounced reduction of engine wear and greater cleanliness of engine parts, even when the lower grade, high sulfur fuels were used. Shell Oil Co.'s experience has been that the average wear under extreme service conditions has been reduced to one-tenth of the former rate of wear where conventional heavy-duty oils were used.

Where the new type oils have been used in gasoline engines, marked improvement in engine wear and sludging conditions have been experienced in fleets in light-duty, stop-and-go service where low engine temperatures are a frequent operating condition.

The experience to date has been sufficient to lead one Diesel engine manufacturer to state that the oils, for commercial heavy-duty service, represent as great an improvement over the present compounded oils as did the first compounded oils over the earlier blends of straight mineral oils. The new oils, it is said, have made practicable the commercial introduction of the present line of Caterpillar super-charged Diesel engines.

Permit Use of High-Sulfur Fuels

These new oils, it is said by automotive engineers, will make practicable the use of the higher-sulfur fuels coming into increasing use in present type Diesel engines without causing undue damage. It is also believed the oils may hasten the development of new models of greater mean effective pressure and engine speeds than would have been possible with the conventional heavy-duty oils of 2-104B specifications.

Laboratory and field work with the new high additive content oils is being carried on by oil companies and engine manufacturers and the Armed Services. The Army is running tests at the Watertown Arsenal, Boston; Frankfort Arsenal, Philadelphia; and Benicia Arsenal, Benicia, Cal., under the direction of the Office of Chief of Ordnance. The tests are in gasoline engines in a variety of vehicles and also in engines in material handling equipment.

The Army is also preparing to run tests on the new oils in gasoline engines in pipeline pumping service at the Aberdeen, Md., proving ground. The purpose of the various Army tests is to determine the practicability, economic as well as technical, of the new oils for service in its automotive ground and other equipment.

Oil company and equipment manu-

TABLE 1—Typical Tests of Shell Rimula Oil

	SAE 10	SAE 30
Gravity, ° API	26.3	22.7
Flash, COC, ° F.	375	435
Fire, ° F.	430	480
Viscosity, SUS at:		
0° F. (extrapolated)	12,500	...
100° F.	214	599
130° F. (interpolated)	111	250
210° F.	47.5	62.8
Viscosity Index (Dean & Davis)	101	70
Pour, ° F.	—25	—15
Corrosion, Cu Strip, 212° F.	Neg.	Neg.
CRC Foam Test:		
ml. foam, Sequence I	0	0
ml. foam, Sequence II	0	0
Total Base No. E.	7.07	7.0

facturer automotive engineers are cooperating with the Army in these tests and the data from test results are being channeled through the Coordinating Research Council, the jointly-sponsored automotive research agency of the American Petroleum Institute and the Society of Automotive Engineers. This is to the end of expediting conclusive data on the performance of the new type oils.

The Navy Department is also said to be planning service tests on the Series 2 oils, under some of the extreme operating conditions the Navy experiences in the use of Diesel engines.

One problem in connection with the use of the high additive oils being given intensive study is that of the possible effect of their high ash content. With oils using a maximum of 20% of additive the ash content of the oil is around 2%, many times that of conventional heavy-duty types. The high ash value is due to the inorganic soluble material in the additive.

Richfield Oil Corp., as a result of its work with the intermediate grade of high-additive oil, has reported no spark plug trouble from high ash content, the plugs being cleaner than before the tests, it is stated. Experience of this company indicates that, in the case of new engines starting out with the new oil, the time required for ring break-in is estimated to be double that required when using a 2-104B oil, in both gasoline and Diesel engines. This was taken to mean a lower rate of wear on all parts despite the high ash content.

Present Commercial Status

The present commercial status of the new high-additive content oils is as follows:

Caterpillar Tractor Co. has issued a list of 44 companies making the oils to its so-called Series 2 requirements. Use of the oils is advised (1) when the fuel sulfur content exceeds 0.5% and (2) for its new model supercharged engines regardless of the quality of fuel used. The company statement accompanying the listing states in part:

"When the effect of high sulfur fuels on engine performance was first indicated, Caterpillar Tractor Co. launched an extensive research program. As a result, new lubricating oils known as Superior Lubricants (Series 2) were developed and they have been very effective in combating the effect of high sulfur fuels.

"These oils also serve a second purpose. Caterpillar Tractor Co. is now manufacturing a line of engines to work at higher ratings which require a higher quality lubricant than has heretofore been available. Superior Lubricants (Series 2) meet this need." The line of engines referred to above is the company's new supercharged models.

Caterpillar Tractor Co., as do other engine manufacturers, continues to recommend the lower cost oils meeting Army Specification 2-104B for their engines with the exceptions given above in which service demands are more severe.

Army Recognizes New Oils

The Army Ordnance Department is recognizing the new type oils by maintaining two supplemental lists to its regular list of qualified suppliers of 2-104B oils. Supplemental List 1, for the intermediate grade (usually carrying from 8 to 12% additive), contains the names of 16 approved suppliers. The preface to Supplemental List 1 states:

"The following oils in addition to meeting all the requirements of U. S. Army Specification 2-104B have been placed on Supplemental List 1 because these oils meet the additional requirements of the AXS-1551, procedure (L-1 engine test) modified by the use of 1% sulfur fuel. These oils were originally developed for use in Diesel engines. Until more data are available no general statements can be made in regard to the performance of these oils in gasoline engines."

Supplemental List 2 of the Army Ordnance Office lists approved oils meeting the requirements of the Caterpillar Tractor Series 2 oils (usually carrying 16 to 20% of additive). The list is the same as the Caterpillar list of approved Series 2 oils, lacking a few companies which have not qualified their new lubes at Armour Research Institute. The preface to this listing states the oils, in addition to meeting the requirements of conventional 2-104B oils and of Supplemental List 1 oils, meet the requirements of Caterpillar Superior Lubricants Series 2. This means they must also pass the new Caterpillar Supercharged 1-D engine test with fuel containing 1% of sulfur.

This listing states also that the oils were originally developed for use in Diesel engines and that more data must be available before statements can be made in regard to their performance in gasoline engines.

General Motors Corp., as is its practice, will issue the Ordnance Office supplemental listings as approved oils for its Diesel engines, where fuels of more than 0.5% sulfur content are used. Its recommendations state:

"Use of 'Super-Duty' lubricants may prove of help in maintaining clean piston skirts, piston rings and air intake ports. In addition, increased engine life is reported as a result of the use of 'Super-Duty' lubricant under unusually severe operating conditions."

Conventional heavy-duty oils are advised where fuels of less than 0.5% sulfur content are used and under normal load conditions.

While other Diesel engine manufacturers have not issued listings of approved new type oils, their bulletins advise their use under extreme heavy-duty operating conditions.

TABLE 2—Typical Tests of Texaco Ursa Oil Super-Duty

	SAE 10	SAE 30
Gravity, °API	25.8	23.2
Flash, COC, ° F.	395	430
Fire, ° F.	435	500
Viscosity, SUS at		
100° F.	201	526
130° F.	104	230
210° F.	46.7	63.5
Viscosity Index	100	91
Color, Tag-Robinson	4	1¼
Pour, ° F.	—15	—10
Corrosion, Cu Strip, 212° F.	Negative	Negative
Neutralization No.	3.2	3.2 Alkaline
Ash, %	2.5	2.5
Carbon Residue	High ash is additive to actual carbon residue and combined amount is not significant	
Almen Value, Lbs.	..	30
CRC Foam Test		
ml. foam, Sequence I	0	0
ml. foam, Sequence II	0	0
ml. foam, Sequence III	0	0
ASTM Rusting Test (distilled water)	No rusting	No rusting

TABLE 3 — Properties of Enjay Co.'s Additive for Series 2 Oils

The active component is described as a balanced combination of metal derivatives of selected organic compounds characterized by the presence of barium, calcium and sulfur. In appearance it is a viscous liquid. Properties are:

Typical Physical	
Viscosity @ 210° F., SSU	110
Flash Point, F.	400
Pour Point, F.	10
Specific Gravity, 60/60° F.	0.994
Weight, avg. lb./gal. @ 60° F.	8.3
Typical Chemical	
Barium, wt. %	5.6
Calcium, wt. %	0.6
Sulfur, wt. %	2.9
Ash, wt. %	10.8
Sulfated Ash, wt. %	11.8
Conradson Carbon, wt. %	12.6
Neutralization No. ASTM	7(basic)

Experimental Work Described

The following section of this article reviews early test programs looking to the development of new types of crankcase oils, chiefly as reported in technical society papers:

The work of Shell Oil Co. in the development of an entirely new type of heavy-duty lubricant started in the laboratory in 1942, the purpose being to reduce the fouling of laboratory fuel testing engines. An oil which

departed radically from conventional compounding methods was tried with outstanding success. Engine cleanliness was found to be excellent, ring and groove deposits disappeared and, contrary to all specifications, combustion chamber deposits were found to be normal.

In view of the results, an entirely new concept of compounding oils was developed and an extensive study of new formulations was made. The development work was carried into the field, the principal objective being to reduce wear in certain engine models in marine service and in stationary engines running under relatively constant operating conditions at high loads and high temperatures regardless of the quality of fuel used.

SAE Paper Discussed Shell's Work

Shell Oil Co.'s work was discussed in a paper prepared by three of its technologists and presented before the SAE, National Fuels and Lubricants meeting, at Tulsa, in November, 1948.(1)

It was pointed out by these authors that the performance features which required study in the new type oil and which it appeared possible to obtain were:

1—Improvement in oxidation stability,

2—Reduction of bearing corrosion,

3—Improved engine cleanliness,

4—Reduction of corrosive cylinder and ring wear.

The study was organized with the object of producing an oil suitable for use over that range of conditions in which conventional heavy-duty oils were not giving the expected performance. The investigation was carried on in laboratory bench and engine tests and finally in prolonged Diesel engine service tests in the field.

Reconciliation of the properties to reduce corrosive wear and those which would give satisfactory ring performance at high temperature finally was proven by the Shell Oil Co. investigators to require:

1—An exceptional degree of oxidation stability,

2—Greater detergency, as such, than had been built into an oil up to this time,

3—Specific additives to nullify the corrosive products of combustion.

Field experience has shown the special heavy-duty type oil able to protect against corrosive wear throughout the periods of use established as good practice in Diesel engines, the paper brings out. However, the marked reduction of corrosive cylinder wear is accompanied by the consumption of additive. When continued service results in the development of a strong acid number, the anticorrosive property disappears.

The laboratory work of the Shell Oil Co. had brought forth indications of substantial reduction in wear of cylinder walls, rings, and other engine parts, under operating conditions when corrosive combustion products could be most effective, it has been stated in another paper by Shell Oil Co. authorities.(2)

This was taken to confirm earlier conclusions that high wear in certain applications at least was caused by corrosion, rather than by abrasion by metal-to-metal contact, aspiration of dust into the engine, or other mechanical means.

The field testing of the Shell Oil Co. special oil was expanded to include studies of wear in a variety of engine models and operating conditions. Three types of service were selected which were known to give unsatisfactory or borderline results.

1—Stationary pumping and drilling units operating at low and high load factors under constant and variable conditions of temperature, speed and load,

2—Marine generator sets operating at a medium load factor under varied conditions of load and temperature but at a constant speed,

3—A marine propulsion unit operating under intermittent high load conditions with corresponding variations in temperature and speed.

The fuels used in the test were those normally used by owners of engines and represented commercially available products. Each engine was carefully inspected prior to the test so the influence of the special oil could be evaluated properly. New pistons, rings, and liners were installed in all engines.

The cylinder wear rate was materially reduced in all engines with the special oil. The maximum reduction was about 95% and the minimum 50%.

Caterpillar Tractor Co. started work in 1945 on the lubrication problems encountered in the operation of Diesel engines, its chief interest centering around overcoming wear and deposit difficulties where high sulfur fuels were used. Its work included both laboratory studies and field tests of wear and engine fouling difficulties on their engines in use in marine service, in irrigation service, as well as other types of use.

Carried Out Extensive Tests

Extensive test work had also been carried on by the company, one series of tests being for the purpose of studying the effect of sulfur content of the fuel on deposits and wear in Diesel engines. This work was reported on by L. A. Blanc, Assistant Director of Research of Caterpillar Tractor Co., before the SAE National Fuels and Lubricants Meeting, Tulsa, November, 1947,(3) and before the SAE National West Coast Meeting, San Francisco, August, 1948.(4)

Most of this reported work was done on the 5¾-in. x 8-in. single-cylinder, "Caterpillar" Diesel test engine under a modification of L-1-545 procedure. The modifications involved the outlet temperature of the cooling water, and the composition of the fuel and lubricating oil used. A variety of oils were used, also an experimental high-additive type oil.

"Two things become immediately clear," it is stated in the paper presented at Tulsa. "First, no heavy-duty oil performs as well on high sulfur fuel as it does on low sulfur fuel, though all perform in some respects better than the straight mineral oil. Second, high-sulfur fuel causes a very much wider spread in the results with heavy-duty oils than low-sulfur fuel. It will be noted there is a definitely large increase in ring wear, and a definite increase in cylinder wear though this increase is small in some cases. The increase in piston deposits is definite with all heavy-duty oils, though in some cases it is more extreme than others.

"In all cases the heavy-duty oils show a marked loss of additive. The straight mineral oil is, as could be expected, the poorest in all respects, though the wear results obtained with some heavy-duty oils are no better. The heavy-duty oils show up in varying degrees better in piston deposits. Outstanding results were obtained with the experimental oil (high additive), which proved itself amply able to counteract both the wear and deposits due to high sulfur fuel at normal operating temperatures. It

ASTM Symposium on The New Motor Oils

Test data on the new high additive crankcase oils will be presented at a symposium on the subject, at the First Pacific Area National Meeting of the American Society of Testing Materials, San Francisco, Oct. 10-14. The symposium, Oct. 12, is sponsored by ASTM Committee D-2, on Petroleum Products and Lubricants. The program:

"Does Service Performance Justify Higher Quality Lubricating Oils", by W. B. Bassett, Lubrizol Corp., Cleveland.

"High Detergency Motor Oils", by A. B. Boehm, Enjay Co., New York, and C. O. Tongberg, Standard Oil Development Co., New York.

"Future Military Engine Oils", by N. L. Klein, Office of Chief of Ordnance, Department of the Army, Washington.

"Five Years Field Performance of Series 2 Oils" by J. A. Edgar and R. E. Jeffrey, Jr., Shell Oil Co., Inc.

is to be noted carefully that this oil was unable to reduce cylinder wear to normal under the lower temperature conditions, though the ring wear under these conditions was quite normal."

"There seems to be reason to believe that cylinder wear with high sulfur fuels orginates with two sets of chemical reactions." it is also stated.(3) "On one of these the lubricating oil has little effect, as shown by the inability to control the wear at lower temperatures with lubricating oil. This wear we refer to as 'cold wear'. We have been able to reduce this wear by the proper choice of cylinder materials or by raising cylinder surface temperatures.

"In the case of wear of the other type, lubricating oils vary in their ability to counteract it, and the oil drain period becomes of great importance. The longer this period is made, the better chance there is that the engine runs under conditions which accelerate wear of this type. It seems possible that this may be caused by a build-up of corrosive materials in the lubricating oil, but it should be noted that acidity as reported here does not correlate with wear."

Two types of Engine Wear

The two types of engine wear with high sulfur fuels are also discussed in the second paper by this authority.(4) "As far as cylinder and ring wear are concerned, there seem to be two originating factors involved," it is stated. "The first is emphasized at low temperatures and is independent of lubricating oil composition. The pitting observed on cylinder surfaces suggests a corrosion reaction. The reduction of this pitting as temperatures are raised indicates that condensation of moisture may occur on the cylinder surface at the lower operating temperatures. . . . .

"The second originating factor seems to be more emphasized at normal cylinder surface temperatures. The mechanism involved is somewhat more uncertain. Wear at such temperatures is more easily controlled by lubricating oil composition. In particular, additive composition seems to be important. The fact that this rate of wear varies with the oil change period supports the suspicion that it originates with a chemical reaction. Examination of the cylinder surfaces, however, does not show the extensive pitting characteristics of the low temperature wear. In addition, the relationship of the wear around the circumference of the cylinder to the temperature distribution is not established by the results. The distribution of wear seems to be more constant under these conditions. For these reasons, it is suggested that this type of wear is, to an important degree, the result of materials in the lubricating oil. Whether the effect is chemical or physical remains to be proved, but the preponderance of evidence indicates it is chemical."

One paper(3) concludes that the engine industry must do what it can to minimize the effects of sulfur, but it is emphasized that the petroleum industry must develop lubricating oils which will help the engines to live with the fuels they have to burn. "The advent of higher output engines with their increase in the ratio of fuel burned to lubricating oil used will serve to emphasize the problem", it is stated.

Texaco Also Active

The Texas Co. carried on development work on the new high additive content crankcase oils from an early date, and cooperative field tests were made with the Caterpillar Tractor Co., on its Texaco Ursa Oil Super Duty. Some results of this work have been published.(5) The following comment is given:

It is noted that the neutralization number is negative or on the alkaline side, which will have some effect in combating the formation of acidic materials. It is stated the high Almen value indicates the oil has some extreme-pressure characteristics and will provide protection where thin film or "boundary lubrication" conditions exist. Anti-Foaming characteristics are above average for the conventional heavy-duty type oils and the results of the ASTM Rusting Test show fairly good rust inhibiting properties.

Field tests were arranged on a 6-cyl. D-13,000 and an 8-cyl., V-type, D-17,000 Caterpillar Diesel in various types of service, including water pumping, mud pump drilling, pipe line pumping and marine auxiliary service. Results were selected as typical of conditions found from a test on a model D-17,000 in oil well drilling service. In preparation for the test the lubrication system was cleaned, filters replaced, strainers washed, and the crankcase filled with new oil. Thereafter, the process was repeated at 240-hr. intervals. Fuel used was 1.02% sulfur.

After 876 hours of service, general test observations showed only very slight evidence of carbon deposit and lacquer in piston ring grooves and lands. Ring wear was normal despite high sulfur fuel. No valve sticking or burning occurred; connecting rod bearings were in excellent condition; crankcase, oil strainers and oil filters were clean.

Difficulties experienced in the heavy-duty operation of automotive equipment on the West Coast after the war initiated the program of Richfield Oil Corp., of California, to develop an improved oil, especially for Diesel engines using fuels of above 0.5% sulfur content. Successful results were achieved with the use of 8 to 12% of a compound of barium additive balanced with corrosion and oxidation inhibitors. This oil was intermediate in additive volume between 2-104B oils and Series 2 oils and is recognized by the Army Ordnance Department in its Supplemental 1 listing.

This company has studied particularly the possible effect of the higher ash content of the oil and it reports no cases of spark plug trouble have developed where the new oils were used. Its experience also indicates that, in the case of new engines starting out with the new oil, the time required for ring break-in is estimated to be about double that required when using 2-104B oils, for both gasoline and Diesel engines, indicating much less wear on parts from ash or other causes with the new oils.

Another advantage of the new type oil reported by Richfield is giving anti-rust and corrosion protection to engines equivalent to that supplied by specification oils for this purpose. This would mean that farmers, contractors, and other operators whose equipment stands idle part of the time, would not have to replace their crankcase oils with a special corrosion preventive oil when their equipment was to be idle for a period.

Lowered Fuel Quality Demands

After completing the laboratory engine test work on their new oil, Richfield in October, 1948, arranged a field test program designating equipment which set up a cross-section of engines and types of service. Field engineers were instructed to closely observe valves, among other points checked. Experience to date indicates that with the new oils, valve life is extended beyond normal both in gasoline and Diesel engines.

Another important result observed was that, where the new oil was used, octane requirements of the engine, especially in the first 10,000 miles of operation, were lowered as much as 7 octane numbers through the elimination of deposits on valves.

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(1) "Special Heavy-Duty Type Engine Oils", by J. A. Edgar, J. M. Plantfeber and R. F. Bergstrom, Shell Oil Co., Inc. Before SAE National Fuels and Lubricants Meeting, Tulsa, Nov. 4-5, 1948.

(2) "Oil Can Control Wear", by R. E. Jeffrey, Jr., and J. M. Plantfeber, Shell Oil Co., Inc. Before National Assn. of Corrosion Engineers, Cincinnati, April, 1949.

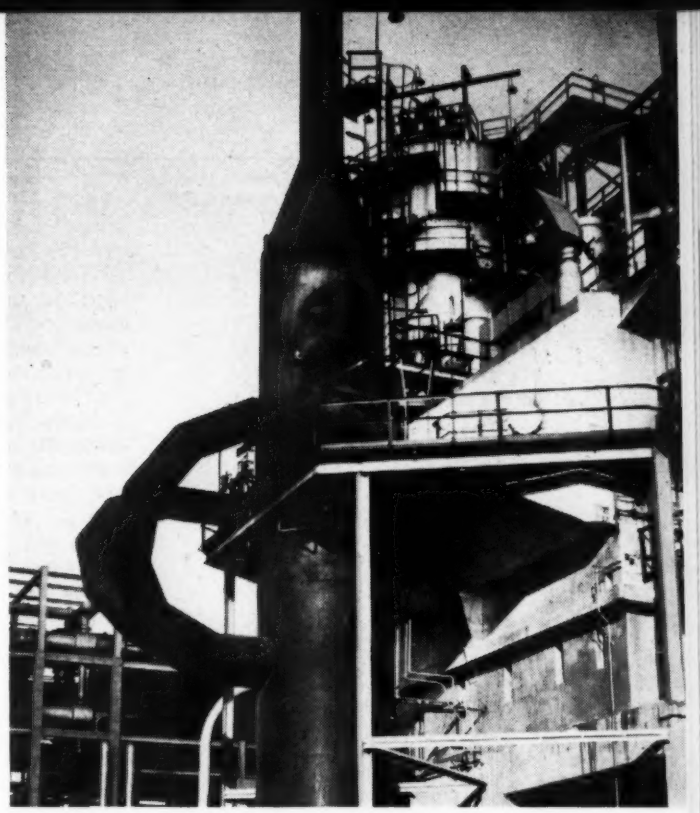
(3) "Effect of Diesel Fuel Characteristics on Engine Deposits and Wear", by L. A. Blanc, Assistant Director of Research, Caterpillar Tractor Co. Before SAE National Fuels and Lubricants Meeting, Tulsa, Nov. 6-7, 1947.

(4) "Some Further Work on High Sulfur Diesel Fuels", by L. A. Blanc, Caterpillar Tractor Co. Before SAE National West Coast Meeting, San Francisco, Aug. 18-20, 1948.

(5) "New Improved Oils Combat Effects of High Sulfur Fuels", *Diesel Power and Diesel Transportation*, January, 1949.

GIANT SILENCER Cuts Noise in Half On Fluid Cracker

By WILLIAM C. UHL
Equipment Editor



Sinclair's silencer for Fluid unit comprises a section of the flue gas stack above the looping inlet lines and below the tapering section

DURING the recent war, when a catalytic cracking unit was first installed at Sinclair Refining Co.'s Sinclair, Wyoming, refinery, the excessive noise created by this unit was disturbing not only in the immediate processing area, but also in areas adjacent to the plant.

At that time it was virtually impossible to obtain materials for building equipment that might eliminate this noise, although its elimination was considered most desirable. Sinclair engineers therefore conducted experiments throughout the war period along that line. At the cessation of hostilities, they submitted this problem, together with the results of their own work, to the Maxim Silencer Co.

As a final result of this development work, Sinclair now has adapted and put into service a piece of equipment for noise suppression found normally, and on a much smaller scale, only in large compressor installations and on pipe line booster pumping stations.

The noise in the case of the cracking unit in Wyoming was caused by vibrations set up when the exhaust gas from the Cottrell precipitators passed through a butterfly valve into the flue gas stack. Sinclair today has noise suppressors installed on the Fluid units both at East Chicago, Indiana, and Marcus Hook, Penna., where they have lessened the whine some 20 to 60% in intensity. These two were put in at the same time the "crackers" were built.

Resembles Gun Silencer

The noise suppressor has the same design as the large mufflers used on Diesel engines—either those on transport trucks and buses or those on huge compressors and pipe line pumps. In fact, it's nothing more than a giant-size "Maxim Silencer" like the ones used on the guns of the killers of a long-forgotten past—the kind we find today in mystery novels.

Designed by the Maxim Silencer Co. to follow ideas developed by Sinclair engineers, the units at East Chicago and Marcus Hook are identical, and were built and installed by C. F. Braun & Co. The original Fluid unit at Sinclair, Wyo., has served as a pilot plant and proving ground for several ideas of the Sinclair engineers. At present, it is covered by an experimental noise suppressor which is operating satisfactorily and which will be described later.

The internal design of the Maxim Silencer is shown in the cutaway view in Fig. 1 and in the drawings in Figs. 2 and 3. Although there is no particular mystery surrounding its principle of operation, great care is exercised in the proper and accurate arrangement of the internal baffles, slots, and holes.

An actual installation is illustrated in the photograph, which shows the flue gas stack on the East Chicago Fluid unit. The silencer forms an integral part of the larger section of the stack, being about 25 ft. high and slightly over 9 ft. in diameter. The height from the ground to the point where the flue gas duct from the precipitators enters the stack structure is about 30 ft.; that from the ground to the tapering section is about 60 ft.

Approximate dimensions are given in Fig. 2. The walls of the outer shell are 7/16-in. plate. Top and bottom heads and the internal partition are 1-in. plate. The lower 14 ft. of the outer wall has been covered with two sheets of No. 10-ga. steel. Two sheets of the same thickness, measuring 44 x 96 in., also are welded across the horizontal partition. (see Fig. 3). The purpose of those laminations is to reduce vibrations still further, because they have a different frequency from the shell itself.

All inner tubular members are of ½-in. plate. The slots in the upper and lower concentric tubes and the holes in the internal tubes are precisely laid out, according to noise suppression principles developed by Maxim engineers.

Three manway openings, 18 x 20 in., for inspection and repairs, have been cut above and below the horizontal partition. There is no lamination on the manway covers.

In general, the muffler follows the design of a standard Model MUC-80 Maxim Silencer. However, it employs heavier metal throughout so as to conform to requirements of a self-supporting stack. Assembly is by welding.

An added feature has been worked out by Sinclair as a safeguard against stoppages due to catalyst plugging. A perforated ring of 2-in. pipe, 72 in. in diameter, is installed in the lower end of the muffler, just above the bottom head; and a perforated spider, comprising a cross of 2-in. pipe, is located in the upper section just above the partition. In the event of a plugged condition, compressed air is admitted to the ring and the spider, whence it passes through 3/16-in. diameter holes into the muffler interior.

Flue gas mixture, under conditions listed in Table 1, passes from the two Cottrell precipitators through a pair of butterfly valves and two 38-in. ducts which join just outside the stack and are connected in a single 38-in. line to the inlet of the muffler. No slip joint is employed. The loop sections of the two ducts take care of normal thermal expansion and contraction.

The reduction in sound intensity on the Fluid unit at East Chicago was reported in a study made by Sinclair engineers and a group of in-

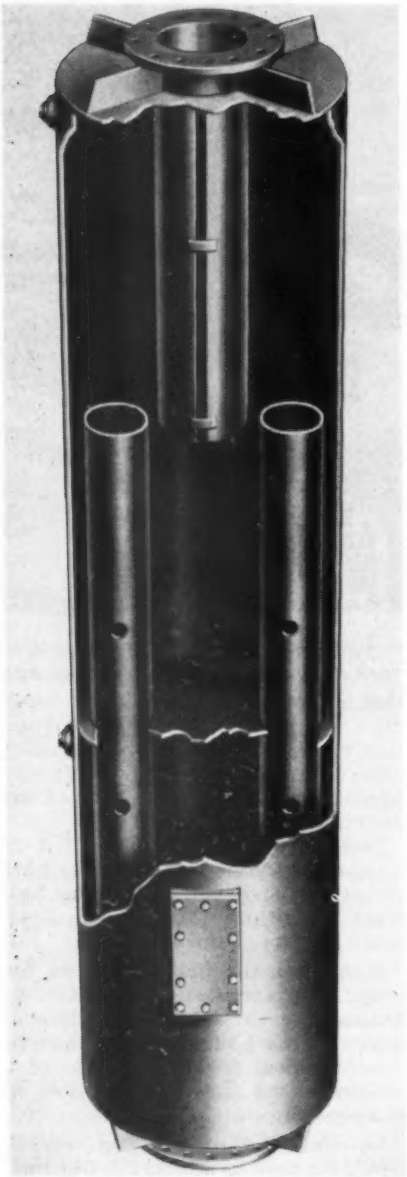


Fig. 1—Cutaway view showing interior construction of the silencer

terested visitors from The Texas Co., Lockport, Ill., refinery, who made a survey July 13, 1948, shortly after the silencer had been installed. Reduction in sound intensity varied from 22 to 61% based on measurements in decibels.

At points along the refinery's north boundary, adjoining East Chicago's residential district, the sound was shown to be 3% less intense than the normal bustle of a business office. "It was actually a strain to catch the sound of the Fluid unit above the normal noise in this area," the report explains. "When an auto passed on 141st St. (a thoroughfare along the property line) the Fluid unit could not be heard at all."

Readings were taken by the study group on a sound level meter manufactured by Electrical Research Products, Inc., a Western Electric subsidiary, and known as a Type RA-330, Serial No. 67. The meter records sounds directly in decibels. A decibel is 1/10 of a bel, the basic unit of measurement for sound intensity. The decibel rating range is not additive, but logarithmic, and is most easily understood by studying Table 2.

For a further understanding of the comparisons, Table 3 shows the effect on the human ear as decibels are reduced from a given level. The actual readings taken at East Chicago are listed in Table 4. They were made at a number of points in the refinery during a period from 10:00 to 11:30 a.m. on July 13, 1948, during which time there was a north wind, increasing in velocity from 5 to 11 mph.

A comparison of these figures with the sound from an average Fluid unit without the silencer, on an "as the ear hears it" basis, shows the sound intensity reduction to vary from 22 to 61%, depending on location, weather, and operating conditions.

A slight back pressure is imposed by the muffler on the flue gas system, but not enough to have an adverse effect on normal operating conditions, according to the Sinclair technologists. The slight back pressure merely causes the butterfly valves to open wider than with a conventional exhaust.

The early experimental work on reducing Fluid unit noise was carried out at the Sinclair, Wyo., refinery. Company engineers learned that other oil companies were experiencing similar conditions, according to reports received from Cities Service Co. at Lake Charles, La., and Esso Standard Oil Co. at Baltimore, Md. A sketch of one of the original attempts at noise suppression devices is shown in Fig. 4.

In this device, a concentric steel shell was placed around a section of the stack which had been perforated. The annular space was filled with asbestos fibre insulation. The arrangement worked quite satisfactorily as a muffler. However, the holes in the stack soon became plugged with catalyst dust, and as a result the muffler ceased to function.

Sinclair then approached Maxim Silencer Co. for an answer to the problem. Maxim's first suggestion was almost identical with Sinclair's first device. Subsequent co-operative development led to the use of the standard silencer, which is now in service at East Chicago and Marcus Hook.

The use of silencers in the petroleum industry is of course not new. Gas and natural gas companies use many of them in large compressor installations and pumping stations. This is the first reported case of their being adapted to use in a refinery. C. F. Braun & Co., who were licensed by Maxim to build the units for Sinclair, report these are the only Fluid units they have built where special silencers are in operation.

Other means for reducing refinery noise have been reported recently. One such case was an installation of fibrous silica pioneered by the Fluor Corp., Ltd., Los Angeles. It was found most effective as a noise

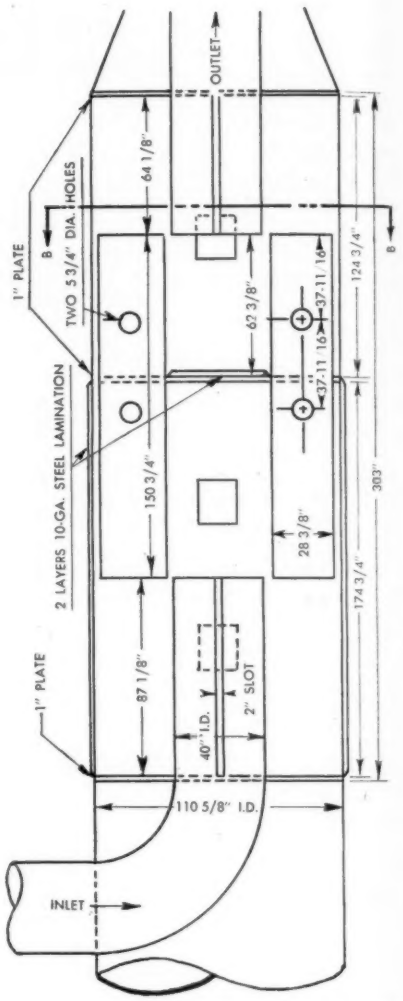


Fig. 2—Dimensioned sketch of the Fluid unit noise suppressor

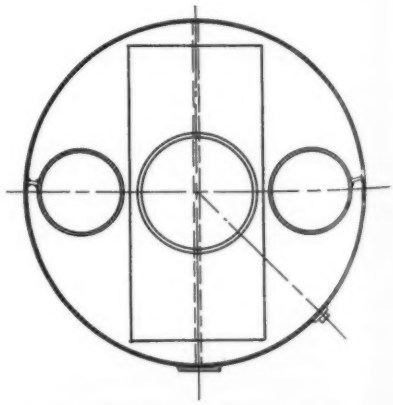


Fig. 3—Section B-B of Fig. 2

suppressor in the regenerator exhaust stack of a catalytic cracking unit. Noise-containing energy was concentrated in the low frequency end of the audible spectrum and was having an adverse morale effect on operating and office personnel in the surrounding area.

Flue gas at a temperature of 1000° F., containing catalyst particles, flowed through the 6-ft. diameter stack at a maximum velocity of 90 ft./sec. The flue stack assembly actually comprised two sections; the 6-ft. diameter one through which the bulk of the exhaust gases vented to the atmosphere; and the other, 3 ft. in diameter and in parallel with the 6-ft. stack, which was used for the automatic control of operating conditions.

Acoustic blankets were made, each consisting of a layer of high-temperature cloth, two layers of fibrous silica batt, ½ inch of superfine fibrous glass batt, and 2½ in. of industrial type fibrous glass batt. The hot side was faced with stainless steel screen.

The completed blankets were fastened to perforated steel liners which were then inserted inside both the main and the auxiliary stacks, downstream from an acoustic converting unit. This latter contrivance was devised to change the low frequency acoustical energy to high frequency sound, in which form it would be absorbed efficiently from the gas stream by the fibrous silica.

The noise at the plant where this was installed was reported to be reduced sufficiently so that it did not bother workers in nearby offices. After nearly one year of operation, the blanket is said to be still intact and performing satisfactorily.(1)

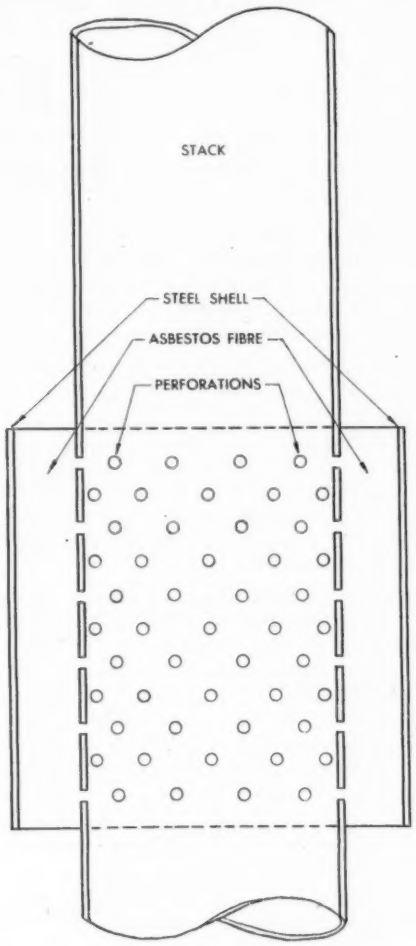


Fig. 4—One of Sinclair's original experimental noise suppressors

Another method for reducing catalytic cracking unit noise, reported recently, incorporates an unusual type of valve for service in vent stacks. It is a single-ported valve with a double slide, so that the opening is always centrally located and never at the outside. It is said to prevent the creation of a distorted gas stream, and impinging type of erosion, and eddy currents that might result in high-pitched sound production. Perforated orifice plates are also used to distribute the pressure drop and have been found to be a factor in reducing the intensity of the sound produced.(2)

W. S. Gullette, assistant chief engineer for Sinclair at East Chicago, is well pleased with the results of the equipment for noise suppressing installed at that plant. He states there is no reason why noise suppressors can't be adapted to any processing unit where noise is an annoying factor, provided they have no adverse effect on operating results.

TABLE 1—Condition of Flue Gas Mixture

Source	Cottrell Precipitator
Vol. rate, flue gas	256,000 lbs./hr.
Water vapor	61,800 lbs./hr.
Catalyst carryover (dry catalytic clay dust)	210 lbs./hr.
Total gas	75,700 SCFM
Temperature	500° F.
Pressure	approx. 1 psig.*

* Pressure is about 1 psig., released from about 7 psig. through the two butterfly valves.

TABLE 2—Examples of Sound Intensity in the Decibel Rating Range

Noise Level (decibels)	Physical Intensity	Example
0	1	Threshold of Hearing
10	10	Whisper at 5 ft.
20	100	Very quiet room
30	1,000	Quiet private office
40	10,000	Subdued conversation
50	100,000	Business office
60	1,000,000	Ordinary conversation
70	10,000,000	Busy city traffic
80	100,000,000	Chicago elevated train at street level
90	1,000,000,000	Pneumatic drill at 10 ft.
100	10,000,000,000	Subway express train passing a local station
110	100,000,000,000	Airplane propeller
120	1,000,000,000,000	Airplane propeller at 10 ft.
130	10,000,000,000,000	Threshold of painful sound

TABLE 3—Noise Reduction as Meter Shows It and as Ear Hears It

If original intensity level was (decibels)	And if the meter shows reductions of: The average ear experiences these percentages of loudness reduction:													
	2	3	4	5	6	7	8	9	10	12	14	16	18	20
40	17	24	31	37	43	48	53	58	63	71	77	82	87	90
50	13	19	25	32	38	43	47	52	56	63	69	75	80	84
60	12	18	24	29	34	38	42	46	50	56	62	69	73	78
70	12	17	22	26	30	34	38	42	45	52	58	64	68	72
80	15	21	27	33	38	42	47	50	54	59	64	67	71	75
90	15	22	28	34	39	44	48	52	55	62	67	72	76	79
100	16	23	30	35	40	44	49	53	57	63	69	74	77	81
110	16	24	30	36	41	46	51	55	59	66	71	75	79	82
120	17	25	32	38	43	48	53	58	61	68	73	77	81	84
130	17	24	31	37	42	47	52	56	60	67	73	77	81	84

TABLE 4—Sound Intensity Readings at Sinclair, East Chicago, July 13, 1948

Location	Decibels
Base of precipitator stack (6 ft. NW)	94–95
Top of prec. stack, west edge, center line	89–90
Top of prec. stack, west edge, SW corner	84
Top of prec. stack, west edge, NW corner	87(1)
Main structure platform at 188 ft. elevation, east of top of stack	86–87
300 ft. S. of unit, directly downwind	67
630 ft. S. of unit, directly downwind	66–67
1540 ft. S. of unit, directly downwind	55–57
3100 ft. S. of unit, directly downwind	48(2)
3400 ft. North of unit, directly upwind	55–60(3)

(1) This reading, although upwind, is higher than that on the SW corner of the precipitator, presumably due to noise picked up from the compressors, and from a "sound well" north of the precipitator.

(2) This reading was of most interest since it was at the north edge of the East Chicago residential district, and according to the decibel range table and corrected for 2 decibel reduction as the ear hears it, it is 3% less noisy than a business office. It was actually a strain to catch the sound of the Fluid unit over and above the normal noise in this area. When an auto passed on 141st Street, the Fluid unit could not be heard.

(3) This was taken at the north boundary of the refinery property, and although 3400 ft. upwind from the unit, it has a higher noise rating than at 3100 ft. downwind (due chiefly to noise of neighboring manufacturing plants.)

References

(1) *Chem. Engrg. Progress*, Vol. 44, No. 12, p. 941, Dec., 1948.

(2) *The Kelloggram*, Issue No. 5, 1948 Series.

FOLLOW THE CURRENT STATUS

Of Product Output, Demand, Stocks, in . . .

REFINING TRENDS

Petroleum Processing's New Regular Feature

THE method of presentation of refining statistics which is being adopted in the new section starting on the page opposite, provides these advantages for readers:

1—The CURRENT TRENDS in volume of products manufactured, in demand at refineries, and in stocks at refineries, principal terminals and in pipelines are arrived at by extending the official Bureau of Mines figures, by means of daily averages of the American Petroleum Institute weekly reports.

While the API figures, issued weekly on a current basis, do not always correspond exactly with the Bureau of Mines figures, published several months later, they do show correctly the TRENDS in operations up-to-date, which are of more immediate importance to plant operators than historical data.

2—The presentation of the trends is VISUAL, by charts, for the reader's convenience. The trends over the past two years are shown for comparison. Supply and demand charts are based on average barrels-per-day figures for each month; stock charts are based on barrels of product on hand on the last day of each month.

The few actual figures given in connection with the charts compare the preceding month with the same month of the previous year, and for the past months of the current year with the same period of the preceding year.

3—The Bureau of Mines FORECASTS of production and demand, by quarters, are included on the charts. These are now the only estimates available to the entire industry of what it is anticipated refining operations will be in coming months. The FORECAST is a yardstick to actual performance if a normal balance of supply, demand and stocks is maintained.

4—Stocks for principal products are shown in terms of DAYS' SUPPLY, as well as in millions of barrels total. For past years, DAYS' SUPPLY is in terms of average forecast demand for the two months following the period at which stocks are given. For current stocks, DAYS' SUPPLY is in terms of the average daily forecast for the coming two months.

5—NATURAL GASOLINE data is included in the presentation. Trend charts show, as nearly up-to-date as statistics are available, the production of propane and butane, and the heavier natural gasoline hydrocarbons. Data for the three avenues of principal demand are also given; natural gasoline blended into motor fuel at refineries, that used direct as motor fuel and that marketed as LPG for fuel and chemical manufacture.

The method of presentation of statistics shown in REFINING TRENDS was reached by the Editors of PETROLEUM PROCESSING after discussions with economists with several oil companies, the API and the Bureau of Mines. The Editors will appreciate suggestions from readers as to how this new feature can be further improved.

This Month's Cover Picture

HUGE SYNTHETIC FUELS PLANT VESSEL SHIPPED BY FLOATING

Photo by Bourdon, courtesy of Wyatt Metal & Boiler Works

ONE of the first large pieces of equipment built for the synthetic hydrocarbon plant of Carthage Hydrocol, Inc., at Brownsville, Texas—a cylindrical vessel, 17 ft. O.D. by 57 ft., 8 in. long—called for unusual handling during shipment. In addition, its size required a unique procedure for stress-relieving.

Weighing 284,000 lbs. and having a wall thickness of 3 in., the vessel was fabricated of carbon-molybdenum alloy, ASTM A-204. Built by Wyatt Metal & Boiler Works at Houston, it was too large for rail shipment. It was also too large for the hold of a cargo ship. But it would float.

It was lowered by crane, as shown in the cover picture, into the Houston Ship Channel and floated out through the Gulf of Mexico to Brownsville. There it was pulled out of the water and skidded to its location. A coating of heavy timbers, to protect it from bumping, was wrapped around the vessel after it was in the water. In addition, pontoons were secured along its sides to prevent rolling.

Moving it from Wyatt's plant to the Channel was not without complications. An oversized, low-bed trailer was required. A special moving permit was needed from the City of Houston, and the trip had to be made after midnight.

Before actual shipment, the vessel required stress-relieving. However, it was too large to go into any available furnace. A special, gas-fired furnace then was built to perform the operation by heat induction. A blower system blew hot combustion gases into the vessel's interior through a connecting duct, raising the temperature to 1200° F. and holding it for the required length of time. A "dress" of 3-in. thick asbestos around the vessel helped retain the heat.

REFINING TRENDS

Distillate Fuel Demand Remains the Key

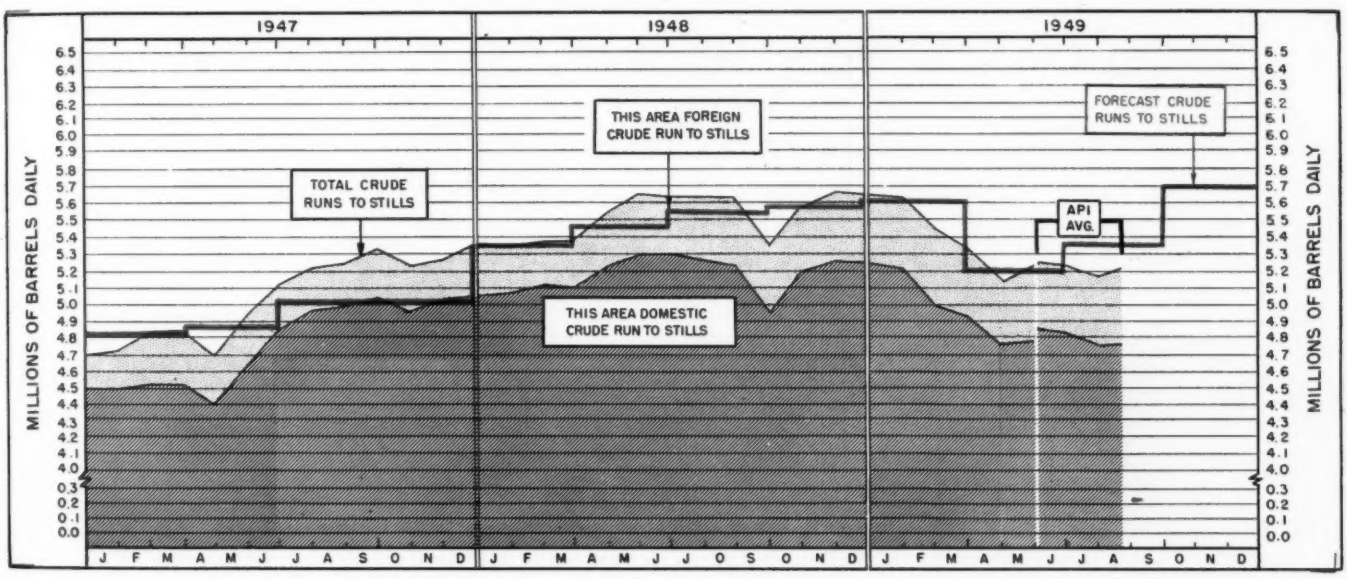
THROUGH the greater part of August, refiners continued their policy of holding down crude runs, meeting gasoline requirements by means of a larger percentage yield of this product from crude, and limiting their additions to fuel oil stocks.

Attention has been called by the Bureau of Mines and other authorities to the possible congestion of distributing facilities if the movement of heating oils is long delayed. Also to the possibility of refiners having to make later readjustments in yields of the distillate oils if the current rate of refinery runs continues.

Total demand for kerosene and distillate fuels for seven months this year, 249,439,000 barrels, is between 8-9% less than for the same period in 1948. Total output of fuels in the distillate range for seven months of this year is 247,000,000 barrels, close to the demand figure.

On the demand side, heating oil authorities state that, by the end of the year, there will be an increase of about 20% in users of oil heat from last winter, meaning a proportionate increase in distillate fuel consumption. If the weather is normal through the winter another 10% increase in consumption would result. These conditions, reflected in refinery demand, might call for supplying around 2,000,000 b/d of distillate fuels for the extreme winter months, a materially higher rate than refiners have ever had to meet.

Fig. 1—Domestic and Foreign Crude Run to Stills


1947
1948
1949
MILLIONS OF BARRELS DAILY
TOTAL CRUDE RUNS TO STILLS
THIS AREA FOREIGN CRUDE RUN TO STILLS
THIS AREA DOMESTIC CRUDE RUN TO STILLS
FORECAST CRUDE RUNS TO STILLS
API AVG.
J F M A M J J A S O N D

Yields on Crude Run to Stills

(Bureau of Mines Data)

	Gasoline	Kerosine	Dist. Fuels	Res. Fuels
June, 1949, %.....	45.9	4.4	15.1	20.4
June, 1948, %.....	41.1	5.6	17.8	22.8
June, 1947, %.....	40.5	5.7	15.8	24.2

End-of-Month Inventories, Refinery Products, 1000 bbls.

	Gasoline	Kerosine	Distillate	Kerosine & Distillate	Residuals
July 31, 1949 (API data).....	109,800	24,595	70,975	95,570	67,183
July 31, 1948 (BofM data).....	98,839	20,958	58,725	79,683	66,262
July 31, 1947 (BofM data).....	86,003	17,651	46,444	64,095	52,808

U. S. Refinery Operations, bbls

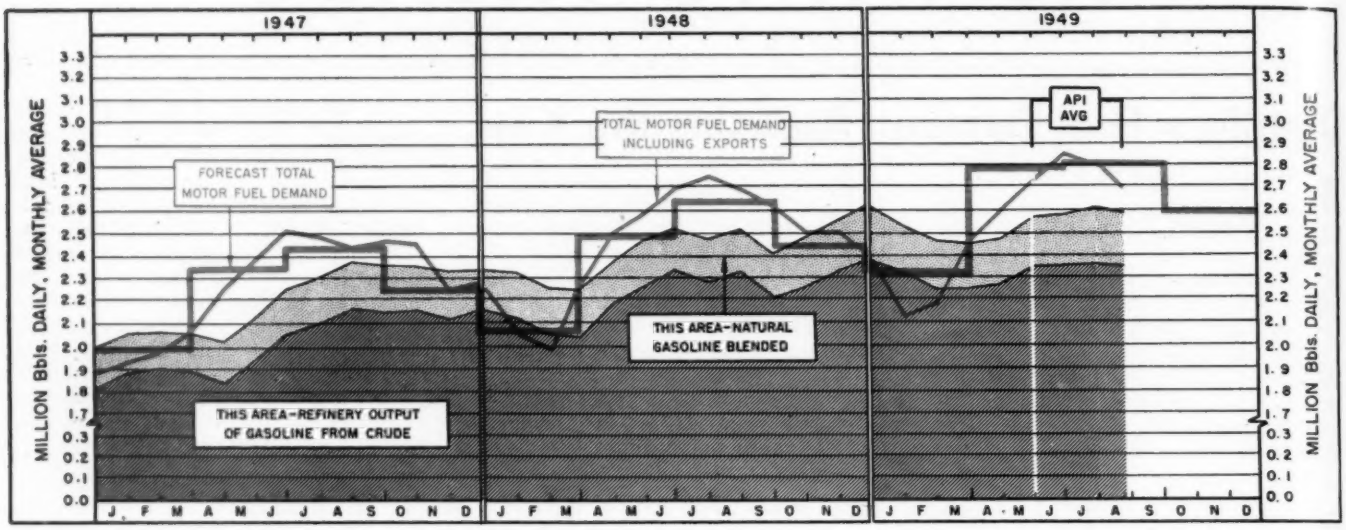
	Crude Run to Stills			Gasoline Production			Distillate Production			Residuals		
	Domestic	Foreign	Total	From Crude	Natural Gasoline	Total	Kerosine	Distillate	Total	Refinery Prod.	Imports	Totals
Aug., 1949, b/d avg.*.....	4,767,000	453,000	5,220,000	2,356,000	240,000	2,596,000	222,130	855,870	1,078,000	1,050,000	150,000	1,200,000
Aug., 1948, b/d avg.....	5,251,000	370,000	5,621,000	2,321,000	211,000	2,532,000	296,100	1,038,400	1,334,500	1,247,500	143,600	1,391,100
Change in 1949, b/d.....	—484,000	+83,000	—399,000	+36,000	+29,000	+64,000	—73,970	—182,530	—256,500	—197,500	+6,400	—191,100
	(—9.2%)	(+22.4%)	(—7.1%)	(+1.6%)	(+13.8%)	(+2.5%)	(—24.9%)	(—17.6%)	(—19.2%)	(—15.8%)	(+4.4%)	(—13.7%)
7 Mos., 1949, 1000 bbls.**..	1,038,734	85,931	1,124,665	543,488	81,867	625,355	57,317	189,786	247,103	251,415	34,107	285,522
7 Mos., 1948, 1000 bbls. ...	1,110,333	63,885	1,174,218	525,486	82,694	608,180	72,023	219,641	291,664	275,071	31,869	306,940
Change in 1949, 1000 bbls...	—71,596	+12,046	—49,553	+18,002	—827	+17,175	—14,706	—29,855	—44,561	—23,656	+2,238	—21,418
	(—6.4%)	(+18.9%)	(—4.2%)	(+3.4%)	(—1.0%)	(+2.8%)	(—20.4%)	(—13.6%)	(—15.3%)	(—8.6%)	(+7.0%)	(—7.0%)

* Average for first 3 weeks only. ** July figures estimated from API reports.

Summary of Statistics on Natural Gasoline

	Production, b/d			Consumption, b/d			End-of-Month Inventories, bbls.		
	Propane & Butane	Heavier Naturals	Total	Blended at Refineries	Supplied Direct As Motor Fuel	Sold as LPG for Fuels, Chemicals	Refineries	Gasoline Plants	Total
June, 1949	136,600	261,900	398,500	243,000	51,000	99,000	2,083,000	4,948,000	7,031,000
June, 1948	125,900	258,100	384,000	199,000	73,000	92,000	1,844,000	4,233,000	6,077,000
6 Mos., 1949	940,900	1,532,000	2,472,900	1,336,000	337,000	701,000	.....	.....	.....
6 Mos., 1948	868,100	1,468,000	2,336,100	1,213,000	367,000	664,000	.....	.....	.....

Fig. 2—Gasoline Supply, Demand and Forecast


1947
1948
1949
MILLION Bbls. DAILY, MONTHLY AVERAGE
FORECAST TOTAL MOTOR FUEL DEMAND
TOTAL MOTOR FUEL DEMAND INCLUDING EXPORTS
API AVG
THIS AREA-NATURAL GASOLINE BLENDED
THIS AREA-REFINERY OUTPUT OF GASOLINE FROM CRUDE
J F M A M J J A S O N D

The forecast of motor fuel demand includes, in addition to refinery gasoline and natural gasoline blended at refineries, natural gasoline used direct as motor fuel. This was at the rate of 51,000 b/d in June, 1949 (see Fig. 10).

Fig. 3—Gasoline Stocks

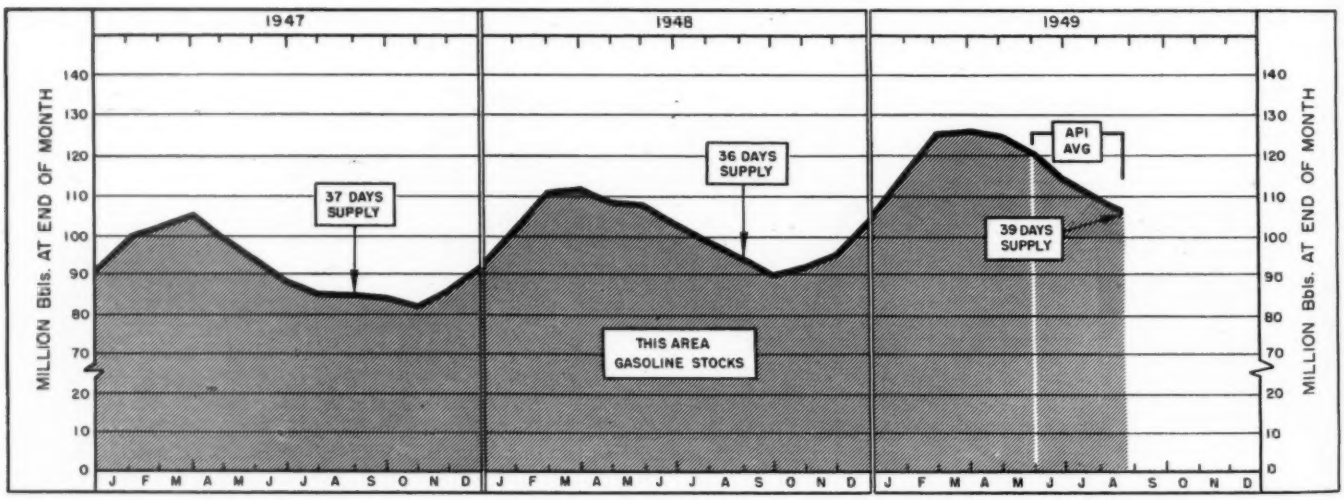


Fig. 4—Kerosine and Distillate Fuel Oil Supply, Demand and Forecast

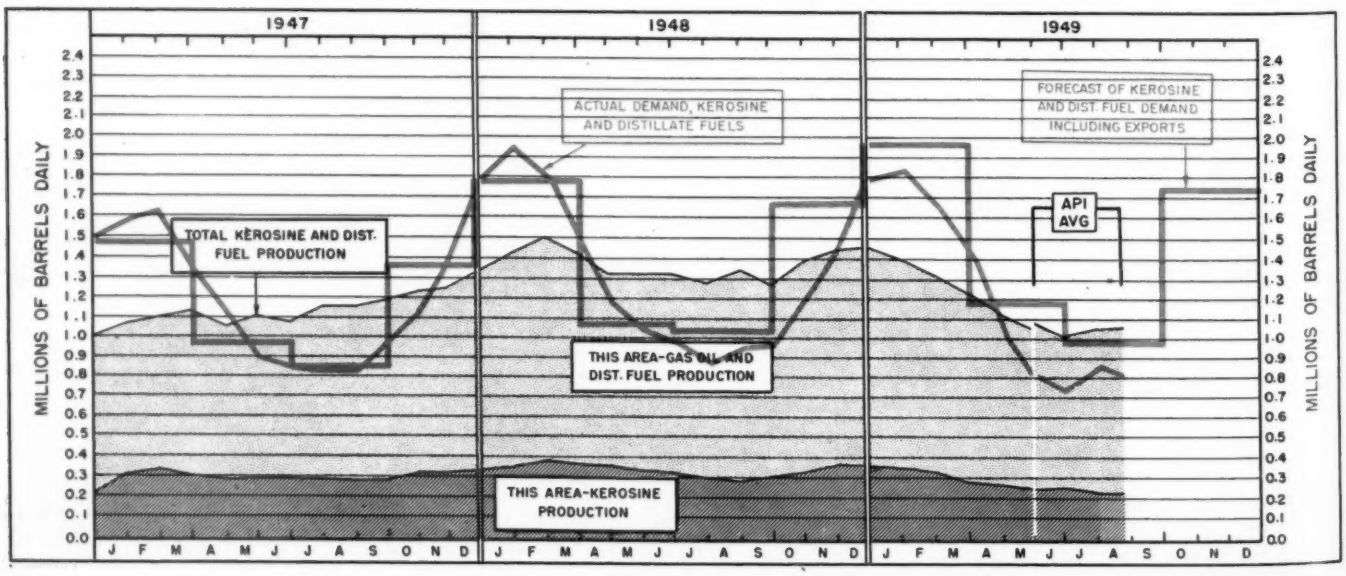
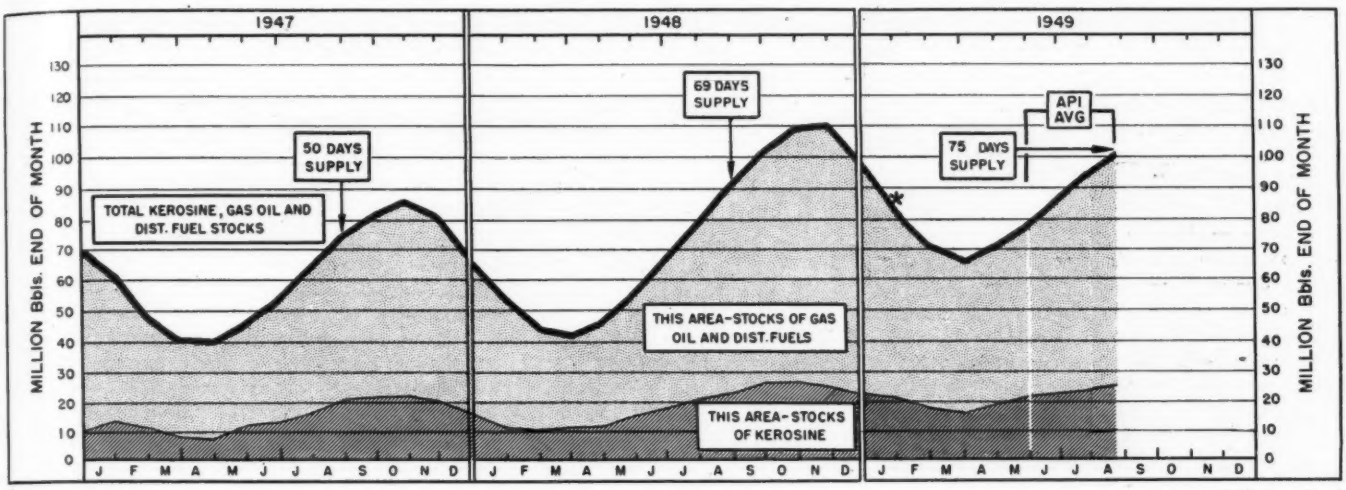

1947
1948
1949
MILLIONS OF BARRELS DAILY
ACTUAL DEMAND, KEROSINE AND DISTILLATE FUELS
FORECAST OF KEROSINE AND DIST. FUEL DEMAND INCLUDING EXPORTS
API AVG
TOTAL KEROSINE AND DIST. FUEL PRODUCTION
THIS AREA-GAS OIL AND DIST. FUEL PRODUCTION
THIS AREA-KEROSINE PRODUCTION
J F M A M J J A S O N D

Fig. 5—Kerosine and Distillate Fuel Oil Stocks


1947
1948
1949
MILLION Bbls. END OF MONTH
50 DAYS SUPPLY
TOTAL KEROSINE, GAS OIL AND DIST. FUEL STOCKS
69 DAYS SUPPLY
API AVG
75 DAYS SUPPLY
THIS AREA-STOCKS OF GAS OIL AND DIST. FUELS
THIS AREA-STOCKS OF KEROSINE
J F M A M J J A S O N D

* About 5,000,000 bbls. of the drop in kerosine and distillate stocks shown in January, 1949, is due to a difference in reporting adopted in California, where cracking stocks were dropped from this classification.

Fig. 6—Residual Fuel Oil Supply, Demand and Forecast

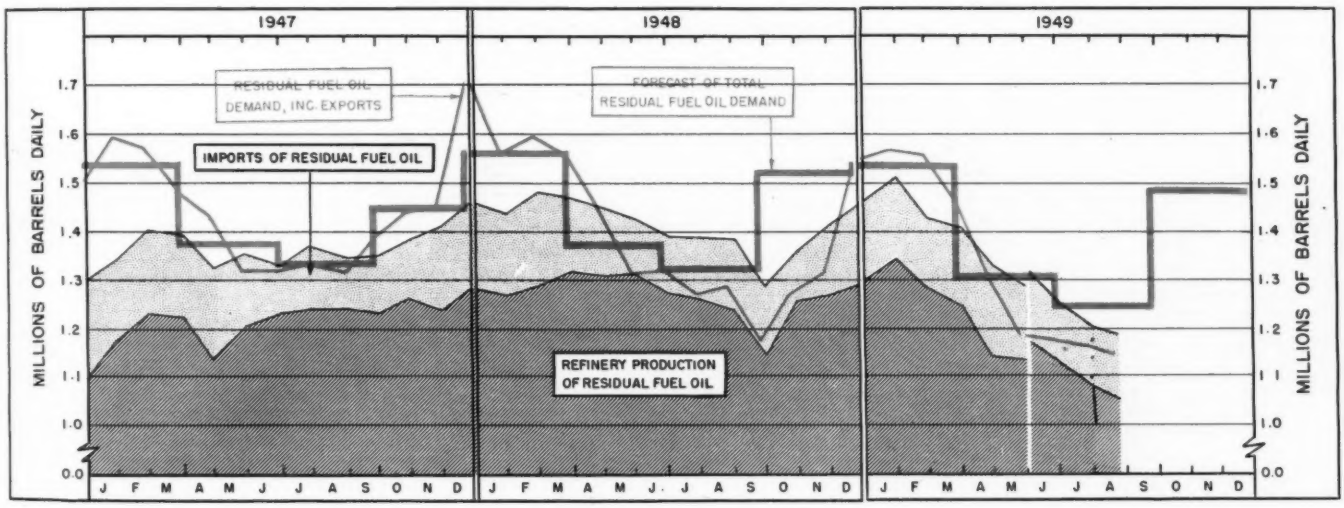
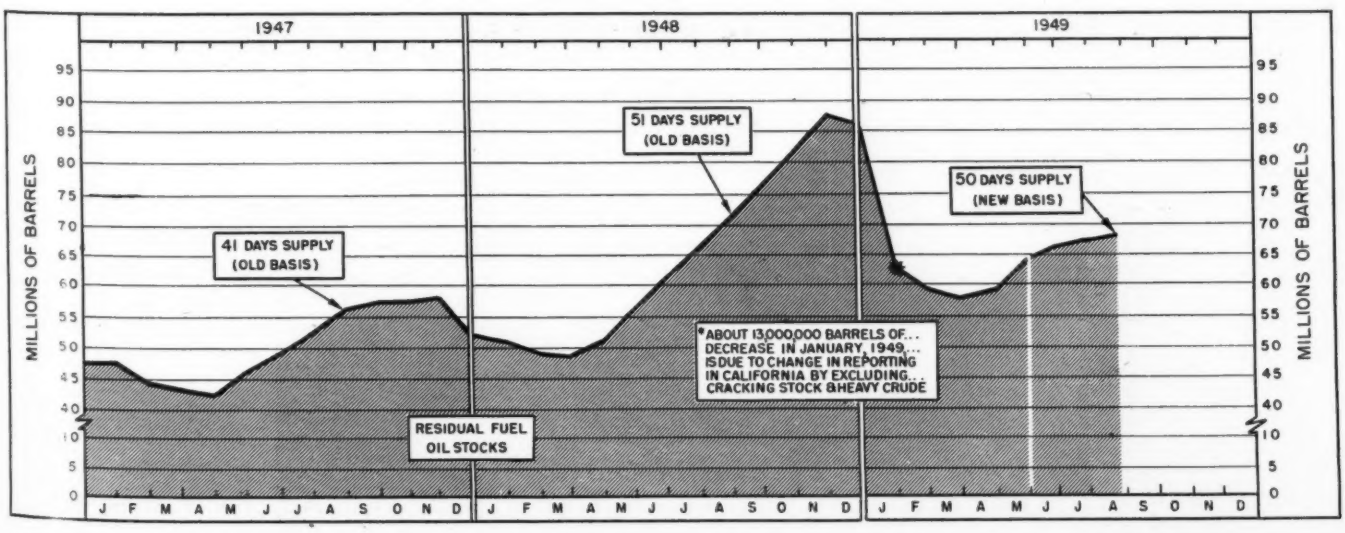

1947
1948
1949
MILLIONS OF BARRELS DAILY
RESIDUAL FUEL OIL DEMAND, INC. EXPORTS
IMPORTS OF RESIDUAL FUEL OIL
FORECAST OF TOTAL RESIDUAL FUEL OIL DEMAND
REFINERY PRODUCTION OF RESIDUAL FUEL OIL
J F M A M J J A S O N D

Fig. 7—Residual Fuel Oil Stocks


1947
1948
1949
MILLIONS OF BARRELS
41 DAYS SUPPLY (OLD BASIS)
51 DAYS SUPPLY (OLD BASIS)
50 DAYS SUPPLY (NEW BASIS)
*ABOUT 13,000,000 BARRELS OF... DECREASE IN JANUARY, 1949... IS DUE TO CHANGE IN REPORTING IN CALIFORNIA BY EXCLUDING... CRACKING STOCK & HEAVY CRUDE
RESIDUAL FUEL OIL STOCKS
J F M A M J J A S O N D

* Residual fuel oil stocks July 31, 1949, (API data) new basis, 67,183,000 bbls. Stocks July 31, 1948, old basis, 66,262,000 bbls; July 31, 1947, 52,808,000 bbls.

Fig. 8—Production of Natural Gasoline and Production Forecast

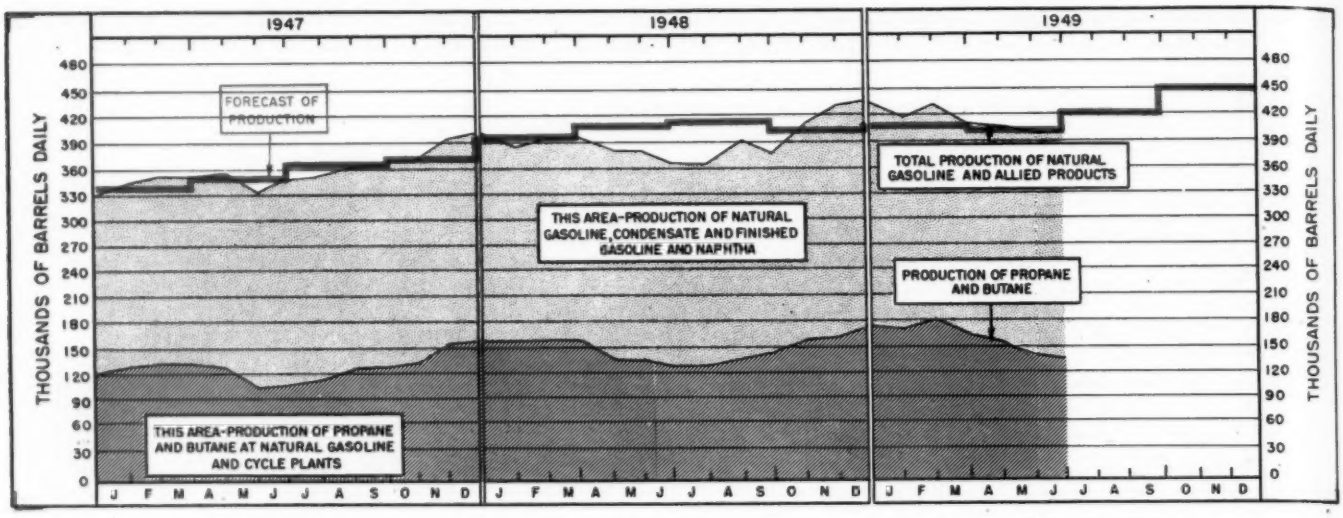

1947
1948
1949
THOUSANDS OF BARRELS DAILY
FORECAST OF PRODUCTION
TOTAL PRODUCTION OF NATURAL GASOLINE AND ALLIED PRODUCTS
THIS AREA-PRODUCTION OF NATURAL GASOLINE, CONDENSATE AND FINISHED GASOLINE AND NAPHTHA
PRODUCTION OF PROPANE AND BUTANE
THIS AREA-PRODUCTION OF PROPANE AND BUTANE AT NATURAL GASOLINE AND CYCLE PLANTS
J F M A M J J A S O N D

Fig. 9—Stocks of Natural Gasoline and Allied Products

(Days supply figured in terms of current demand)

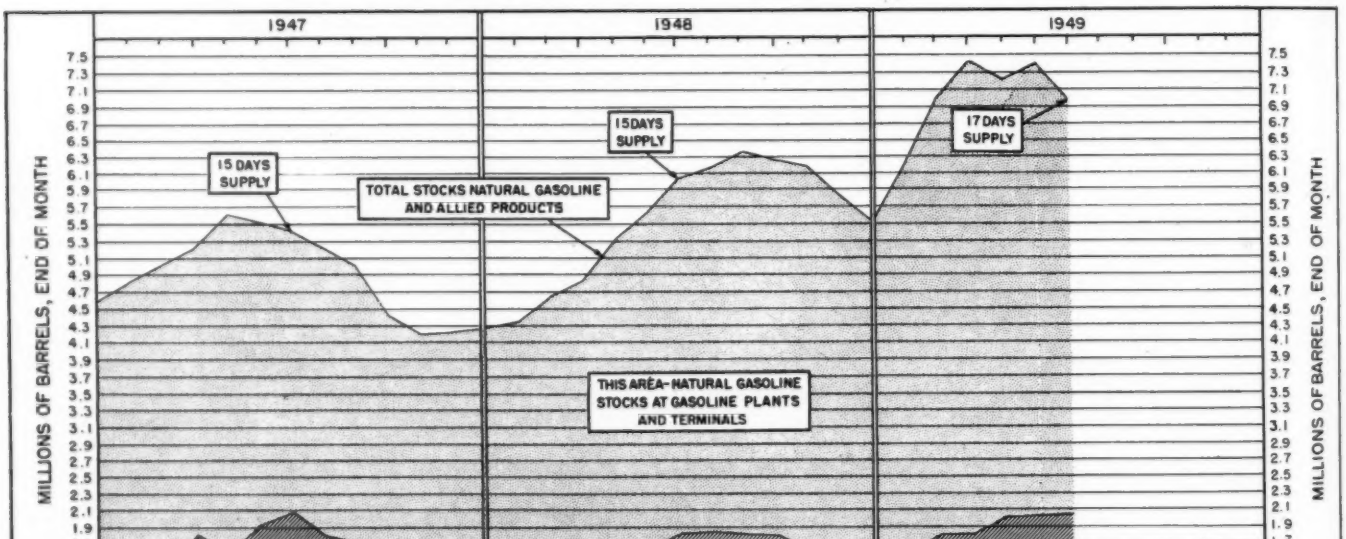
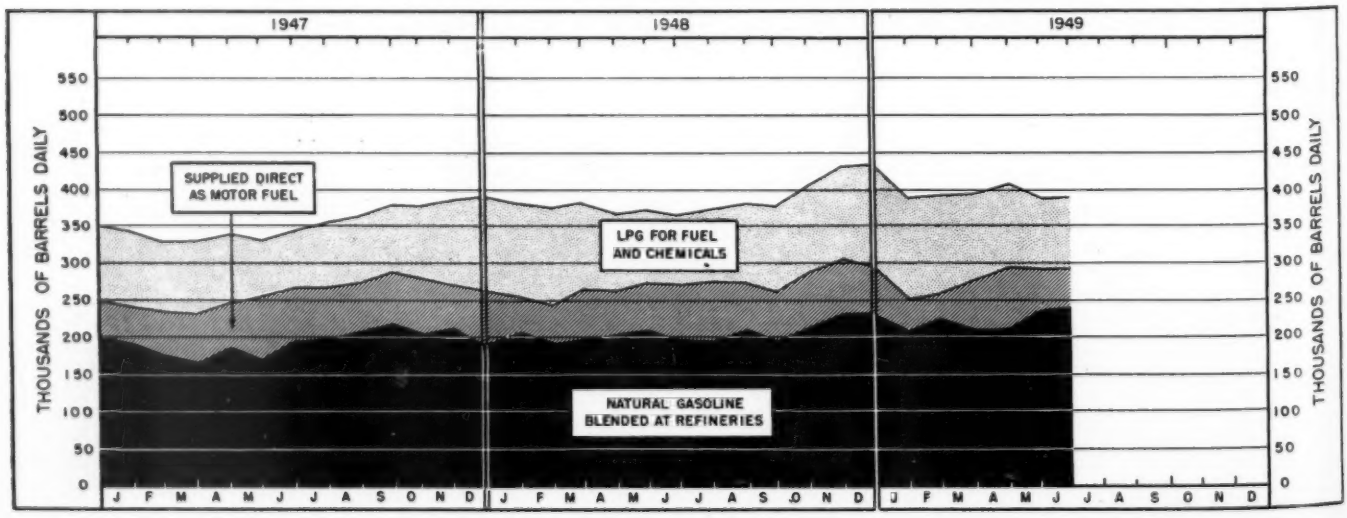

1947
1948
1949
MILLIONS OF BARRELS, END OF MONTH
15 DAYS SUPPLY
TOTAL STOCKS NATURAL GASOLINE AND ALLIED PRODUCTS
15 DAYS SUPPLY
17 DAYS SUPPLY
THIS AREA-NATURAL GASOLINE STOCKS AT GASOLINE PLANTS AND TERMINALS
THIS AREA-NATURAL GASOLINE STOCKS AT REFINERIES
J F M A M J J A S O N D

Fig. 10—Principal Demand for Natural Gasoline


1947
1948
1949
THOUSANDS OF BARRELS DAILY
SUPPLIED DIRECT AS MOTOR FUEL
LPG FOR FUEL AND CHEMICALS
NATURAL GASOLINE BLENDED AT REFINERIES
J F M A M J J A S O N D

Refrigeration-Compression System Boosts Propane Recovery to 70%

By WILL SWERDLOFF, Economics & Development Section Chief
Natural Gas Department, Magnolia Petroleum Co.

The refrigeration-compression process was found applicable to increase propane recovery in Magnolia Petroleum Co.'s Sabine plant near Kilgore, Texas, where the rich inlet gas rate fluctuates widely. The conversion of the plant, which used vapor rectification method previously, employed practically all existing equipment, requiring as new installations only additional heat exchangers, dehydration and refrigeration equipment, and a raw gasoline surge tank. No new fractionators were needed. The recovery column has become the de-ethanizer. The depropanizer and debutanizer continue their previous functions. Original water circulation by steam turbine has been replaced by electrically-driven centrifugal pumps, three 1650-gpm. verticals for process water and three 1000 gpm. horizontals for engine water, with one of each type as standbys.

MAGNOLIA Petroleum Co. has completed a large expansion program at its Sabine gasoline plant, near Kilgore, Texas, increasing the recovery of propane from 40 to 70% and improving auxiliary facilities. Propane recovery was increased by converting the plant recovery cycle from vapor rectification to a refrigeration-compression system. The aim of the auxiliary work has been to decrease the consumption of residue gas and to simplify maintenance work.

The original plant, which was started up April 22, 1935, was operated by Sabine Valley Gasoline Co., Inc. until Oct. 1, 1946, when it was purchased by Magnolia. At the time of the purchase and until the expansion program was completed, the plant utilized the vapor rectification method to obtain its products. In that process, the total rich gas was compressed to about 275 psig. and fractionated in a recovery column. This fractionator, equipped with refrigerated reflux condensers, separated the total liquid product from the residue gas. The specific liquid products then were separated in a subsequent depropanizer and a debutanizer. A propane recovery of about 40% was obtained.

During the planning stage on the converted plant, several alternate schemes were considered for increasing propane recovery. These included vapor rectification, refrigeration-compression, and oil absorption processes. As a result of these studies, it was decided to revise the existing process to a refrigeration-compression system which would recover about 70% of the propane in the inlet rich gas.

With the refrigeration-compression process the rich inlet gas is chilled to make the raw gasoline. The uncondensed gas is the principal residue stream. The raw gasoline is separated in a surge tank and enters the fractionation system where the products are purified and separated.

The process is particularly suited to those cases as at Sabine where the rich inlet gas rate fluctuates. Since only the raw liquid gasoline is fractionated, it can be accumulated in the surge tank. The feed rate to the fractionation system can be regulated so the columns are protected from large fluctuations in the inlet gas rate.

Table 1 presents an overall material balance for the installed process and the analysis of the raw gasoline. It is based on processing a daily average gas volume of 8,000 MCF. per day and cooling it with refrigeration to 13° F.

The table shows how refrigerating the very rich inlet gas containing about 13.5 gal/MCF of propane and heavier products gives a high product recovery. No oil absorption or other means are necessary. Merely cooling the rich gas is sufficient to condense the raw gasoline.

Process Description

The process flow may be followed in Fig. 1. The rich gas is compressed in two stages from a vacuum of 10 in. of mercury to 290 psia. Condensate formed after the first stage of compression is blended with the discharge of the second stage to aid condensation. The total high pressure rich gas, after being cooled by water to 92° F., is cooled to 84° F. by heat exchange with the total residue gas. The temperature of the cold residue is 13° F. or lower depend-

TABLE 1—Overall Material Balance

Basis: 8,000 MCFD* Rich Gas Refrigerated to 13° F. at 265 psia.

	Inlet Gas			Total Residue Gas	Raw Gasoline		Total Finished Product		Overall Per Cent Recovery
	Mol %	Gpm-C_2+	Gal/Day	Mol %	Mol %	Gal/Day	Mol %	Gal/Day	
Air	3.00		4,350	4.77	0.20	160	....	.....	....
Methane	37.89		51,380	60.32	11.66	8,440	....	.....	....
Ethane	14.81		30,110	23.28	15.04	16,340	0.50	370	1.24
Propane	23.20	6.31	50,920	10.15	35.34	41,430	45.25	36,930	72.52
Isobutane	4.03	1.31	10,520	0.49	6.96	9,710	10.01	9,710	92.34
n-Butane	10.08	3.17	25,370	0.86	17.86	24,010	25.66	24,010	94.65
Isopentane	2.25	0.82	6,570	0.07	4.13	6,450	5.94	6,560	98.14
n-Pentane	2.37	0.86	6,850	0.05	4.38	6,760	6.29	6,760	98.64
Hexanes	1.42	0.58	4,660	0.01	2.65	4,640	3.80	4,640	99.64
Heptanes (+)	0.95	0.49	3,880	....	1.78	3,880	2.55	3,880	100.00
Total	100.00	13.54	194,610	100.00	100.00	121,820	100.00	92,750	
Gas Volume, MCFD		8,000		5,025				2,975	

*Standard Cubic Feet Measured at 14.7 psia. and 60° F.

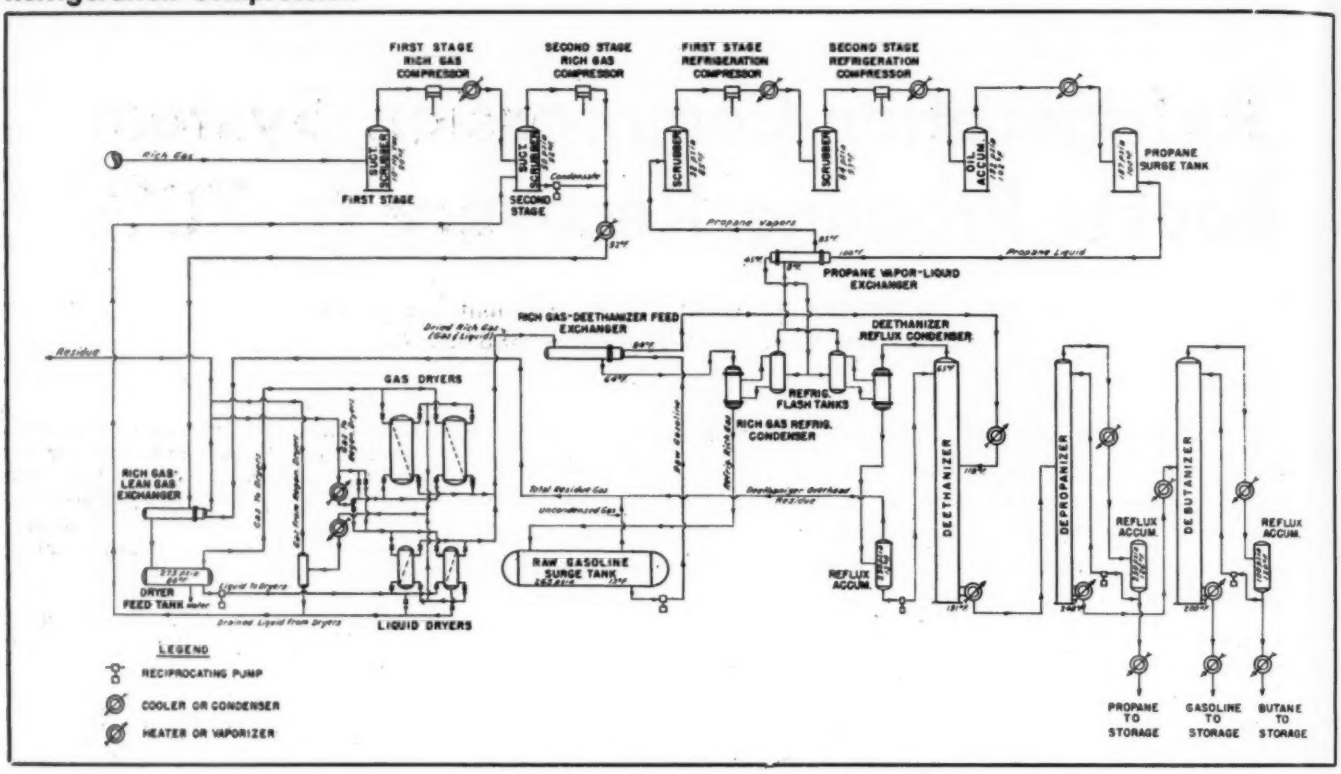


Fig. 1—Flow diagram for Magnolia's refrigeration-compression process

ing on the gas load to the plant.

The total cooled gas then flows to the dryer feed tank. The total rich gas must be dehydrated to prevent the formation of hydrates in the refrigeration equipment. The calculated hydrate formation temperature is 58° F. at 275 psia. The dryer feed tank serves to separate water, which is discarded, and condensed hydrocarbons from the uncondensed gas. The two hydrocarbon phases are fed to separate drying units. Each dehydration unit is of the solid desiccant type. Activated alumina and S/V Sovabeads are employed as the dehydration agent in both the liquid and gas dryers. The gas flow is downward during the dehydration cycle. An upward direction is used during drying the liquid to decrease the possibility of entrained water loading the drying agent. Both drying units are regenerated in a countercurrent direction with residue gas heated to 350° F. Since the residue gas has been dehydrated previously, its direction is left unchanged for the cooling portion of the regeneration period.

After being dehydrated the two hydrocarbon phases are recombined and flow to the rich gas-de-ethanizer feed heat exchanger. Here the rich gas is cooled by cold raw gasoline to about 64° F. The raw gasoline being pumped to the de-ethanizer is about 13° F. or colder, depending on the rich gas volume.

The total rich gas then flows to the refrigerated rich gas condensers where it is cooled to final temperature by boiling propane. The condensed hydrocarbon liquid and uncondensed gas then flow to the raw gasoline surge tank. Here the main plant residue stream is separated from the raw gasoline. The raw gasoline then is pumped to the de-ethanizer as previously mentioned.

The de-ethanizer is equipped with a refrigated reflux condenser using propane as the refrigerant. The temperature of the reflux is 13° F. or lower, varying with the temperature and composition of the raw gasoline. The feed to the deethanizer is preheated by exhaust steam from various pumps in the process area. After de-ethanizing, the total liquid is separated into specification products in the depropanizer followed by the debutanizer.

The finished propane product is pumped to a tank car loading rack about five miles from the plant. A new vertical centrifugal pump driven by an electric motor has been installed for the purpose. The heavier products are disposed of by pipeline by means of steam driven reciprocating pumps.

Refrigeration Cycle

The liquid refrigerant for both the rich gas and de-ethanizer reflux condensers is supplied by a single refrigeration system. The liquid propane flows from the propane surge tank through the propane vapor-liquid exchanger. Here the refrigeration remaining in the propane vapor evolved from the two condensers is utilized to cool the liquid propane to about 45° F. The liquid propane then is divided into two parts, one for the rich gas condensers and the other for the de-ethanizer reflux condenser. Each set of condensers is preceded by a refrigerant flash tank. These act to separate the vapors that flash from the entering propane. Also, propane vapors that are evolved from the refrigerated condensers pass through the flash tanks so that entrained liquid may be separated. The evolved vapors pass through the vapor-liquid exchanger to the refrigerant compressors. Here they are compressed in two stages to a pressure causing condensation at 100° F.

A desuperheating step precedes the condensation of propane to separate lubricating oil and decrease contamination of the refrigerant.

While the daily average gas volume reaches 8,000 MCFD, the rates during the day may be as high as 12,000 MCFD and as low as 4,000 MCFD. In order not to waste refrigeration capacity no attempt is made to refrigerate the rich gas to a constant temperature. As a result, the temperature of the cooled gas varies with the gas volume—the lower the gas volume, the lower the temperature.

Fig. 2 shows the system devised to control and coordinate the two refrigeration demands. With it we assure the proper refluxing of the de-ethanizer and maximum cooling of the rich gas. To be certain of proper fractionation, the control system has been designed to give the de-ethanizer first call on the refrigerant. Actually, the quantity of refrigerant needed by the de-ethanizer is a lesser part of the total. The condensation of the de-ethanizer reflux is controlled by a back pressure valve in the vaporized refrigerant line from the de-ethanizer refrigerant flash tank. This back pressure

varies the temperature at which the refrigerant boils, and, thereby, affects the condensation of reflux.

The reflux requirement is set on a rate-of-flow controller which is not shown on Fig. 2. This reflux requirement affects the liquid level in the de-ethanizer reflux accumulator. It is this level which operates the back pressure valve to make the required reflux.

The pressure downstream from the de-ethanizer back pressure controller must always be less than the pressure upstream necessary to make the de-ethanizer reflux. Therefore, the quantity of vaporized refrigerant from the rich gas refrigerant flash tank which joins with the first refrigerant must always be less than the quantity which would destroy the pressure drop across the back pressure valve on the de-ethanizer refrigerant flash tank. At the same time, in order to obtain maximum output from the refrigeration compressors, the suction pressure should be as high as possible.

The differential pressure controller has, therefore, been provided to admit just enough refrigerant vapors from the rich gas refrigerant flash tank to keep the pressure drop across the de-ethanizer refrigerant back pressure valve not less than a predetermined value, about 5 psi. As a result, if the rich gas volume is large enough to boil up sufficient refrigerant, the pressure to the compressors will be about 5 psi. less than that necessary to make the de-ethanizer reflux.

If the gas volume falls to the point where there is not sufficient rich gas to boil up the necessary vapors, the back pressure regulator on the rich gas refrigerant flash tank will be completely open. Consequently, the temperature to which the rich gas is refrigerated will be a function of the volume of rich gas and the capacity of the compressors at the suction pressure as dictated by the de-ethanizer refrigerant flash tank. The pressure drop across the back pressure controller on the de-ethanizer refrigerant flash tank may vary with the rich gas load but the differential pressure controller will not permit it to be less than the set amount.

With the described control system the rich gas will be utilizing as much refrigeration capacity as possible and its temperature will vary with the gas volume. Without such a control system we could have an alternate such that the temperature to which the rich gas is cooled is held constant. With such a constant temperature system refrigeration capacity would be wasted when gas volumes decreased unless the set temperature was changed. Also it would be difficult to coordinate the two refrigeration demands.

The temperature at which the de-

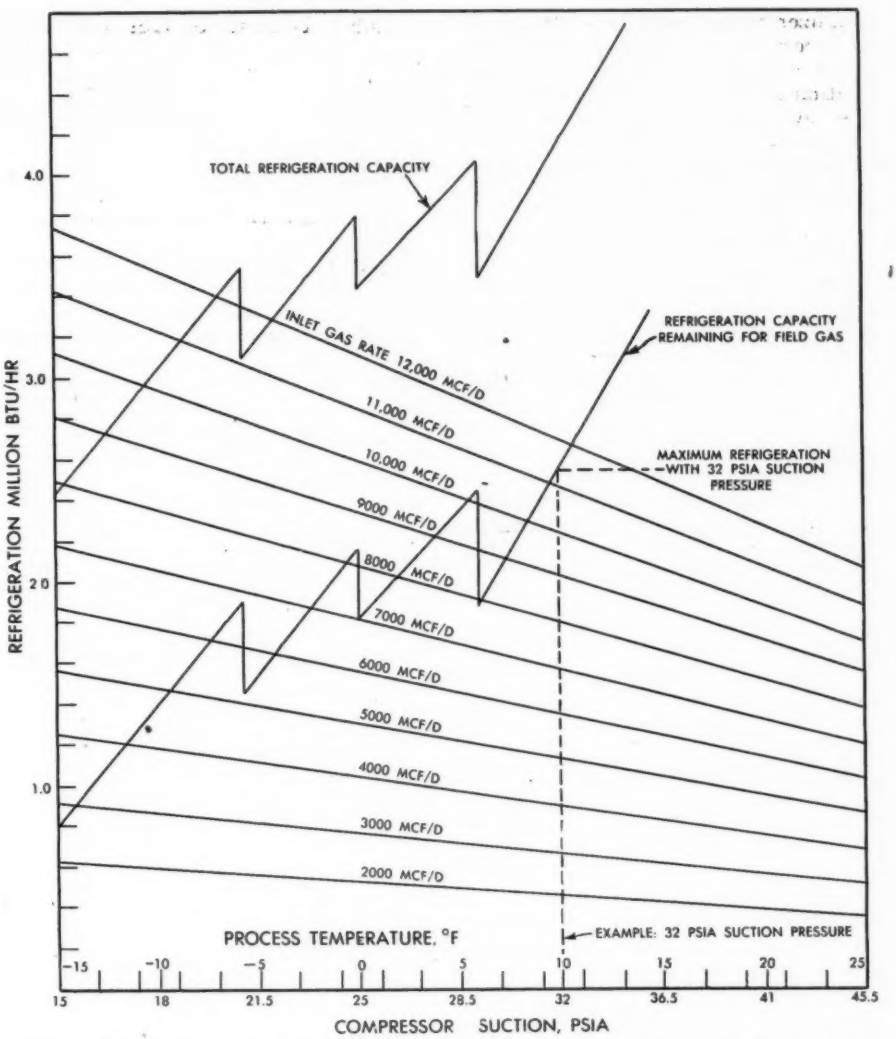


Fig. 3—Refrigerant capacity vs. requirements for various field gas volumes. Note: curves are based on a) constant load for de-ethanizer reflux condenser, b) temperature approach, process to refrigerant, 5° F., and c) pressure difference, evaporators and compressor suction, 10 psia.

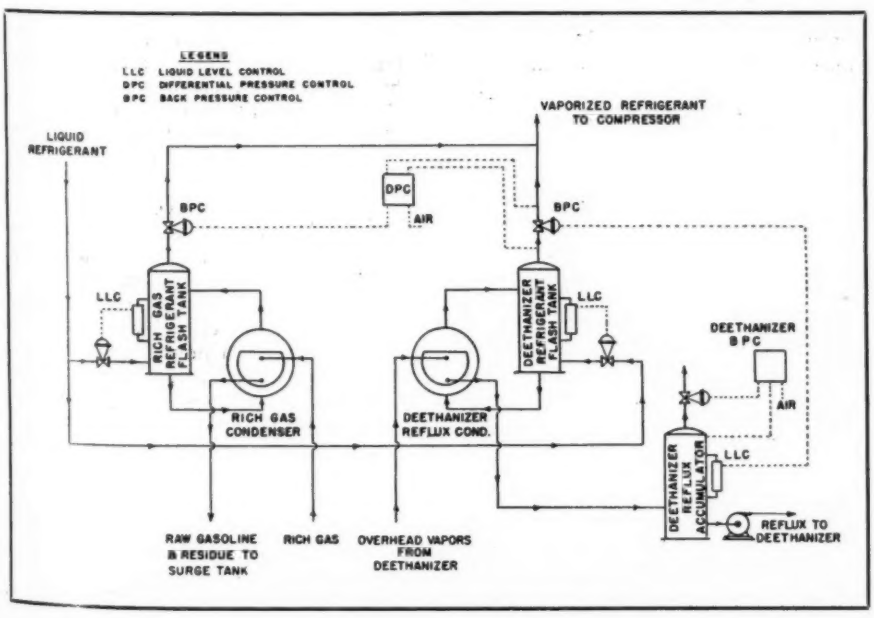


Fig. 2—Refrigerant control system

ethanizer reflux condenses and hence the pressure at which the refrigerant is evolved will vary as the composition of the raw gasoline changes. The cylinders of the refrigeration compressors are sized for the lowest expected suction pressure. They are equipped with an automatic clearance pocket system to prevent overloading at the higher suction pressures that may also occur.

Fig. 3 presents the total refrigerating capacity of the refrigeration compressors, the capacity remaining to cool the field gas assuming a constant requirement for the de-ethanizer and the refrigeration load required to cool rich gas volumes to various temperatures. The points where the lines of constant gas volume cross the field gas refrigeration capacity curve give the temperatures to which the various gas volumes can be cooled by the available refrigeration.

Table 2 presents data obtained from Fig. 3 and gives the calculated temperatures to which various field gas volumes can be cooled by the installed equipment when the compressor suction pressure to make the de-ethanizer reflux is 32 psia.

It will be noted in Table 2 that the temperature to which a given gas volume is cooled may vary depending on whether the gas rate is increasing or decreasing. This variation is caused by the operation of the clearance pockets, as shown by the drops in Fig. 3. Fortunately when gas volumes are increasing, the condition prevailing during the day, the temperatures are at their lowest level. When gas volumes are decreasing, as during the night, we will have small volumes and very low temperatures with the automatic operation.

Fig. 4 shows the effect of temperature on the condensation of the rich gas. The extent of liquefaction is shown both by components and on the total mols of inlet gas. The fact that over 50% of the inlet gas condenses at temperatures below 19° F. shows how well the rich inlet gas lends itself to product recovery by refrigeration. Fig. 4 also indicates the production to be gained by permitting the temperature to which the rich gas is refrigerated to vary, as previously described. Fluctuations in composition of the raw gasoline are minimized by the raw gasoline surge tank.

TABLE 2—Effect of Gas Volume on Temperature to Which Gas is Cooled

Gas Volume Rate, MCFD	Temperature, ° F		
	When Gas Rate Is Increasing During Day	When Gas Rate Is Decreasing From Maximum of 10,000 MCFD	When Gas Rate Is Decreasing From Maximum of 12,000 MCFD
4,000	—11.6	—11.6	—11.6
6,000	— 7.4	— 4.2	— 4.2
8,000	— 0.5	+ 2.0	+ 6.2
10,000	+ 5.5	+ 5.5	+ 8.5
12,000	+13.4		+13.4

With the exception of the refrigeration system, the controls of the process are conventional.

Equipment

In converting the plant to the refrigeration-compression system practically all of the existing process equipment in good condition was utilized. As mentioned before, in the vapor rectification process the total rich gas after being compressed enters the recovery column where the total products were separated. To change the plant to the refrigeration-compression process it was necessary to install the heat exchangers, dehydration and refrigeration equipment and the raw gasoline surge tank between the discharge of the rich gas compressors and the recovery column. The latter column has become the de-ethanizer of the revised process. With the depropanizer and debutanizer continuing their previous functions, no new fractionators were needed for the revised plant.

A few words should be said about the sequence of heat exchangers for cooling the rich gas. It is desired to cool the rich gas by heat exchange before the dehydration step to as close to the hydrate formation temperature as possible. This lessens the load on the dryers by decreasing the amount of water to be removed. However, there is danger that there could be a progressive accumulation of hydrates because of the low tube skin temperatures caused by the cold side of the heat exchangers.

The rich gas is first heat exchanged before the dryers with the lean gas instead of with the de-ethanizer feed because the lean gas film has a poorer heat transfer coefficient. Also the lean gas has a lesser refrigeration ability. The de-ethanizer feed has a greater refrigeration ability both because of its greater weight and because it partly evaporates as it is warmed and acts like a boiling refrigerant. Hence the heat exchange with the de-ethanizer feed occurs after the dryers.

The refrigerated reflux condensing equipment of the recovery column contained sufficient heat exchange surface for both condensing the reflux of the de-ethanizer and the rich gas. Piping changes and the addition of a refrigerant flash tank were necessary for adapting the surface.

Because of fluctuations in the rich gas volume, all plant equipment up to the raw gasoline surge tank is designed for a gas volume of 12,000 MCFD. The equipment after the surge tank is designed to handle the raw gasoline from a rich gas volume of 9,000 MCFD.

The following descriptions concern the more important equipment:

The compressor room contains twelve 230-hp. horizontal units for handling the rich gas and three 230-hp. similar units for compressing the refrigerant vapors. Only one of these units was added during the process change to provide more refrigeration capacity.

The gas drying vessels are each 42 in. ID. by 16 ft.-6 in. seam-to-seam. Each contains 6,500 lbs. of desiccant. The liquid dryers are 20 in. OD. by 8 ft.-10 in. seam-to-seam. Each of these contains 700 lbs. of desiccant. Both dehydration systems operate on an 8-hr. dehydration cycle. One set of regeneration gas heaters and coolers serves both units.

The raw gasoline surge tank is 10 ft. ID. and has a volume of 38,000 gals. As shown by Fig. 3, its temperature varies from about —14° F. to 13° F. depending on gas load. This surge tank is the largest of the new equipment. It weighs 55 tons.

The refrigerated rich gas condensers contain 2,800 sq. ft. of heat trans-

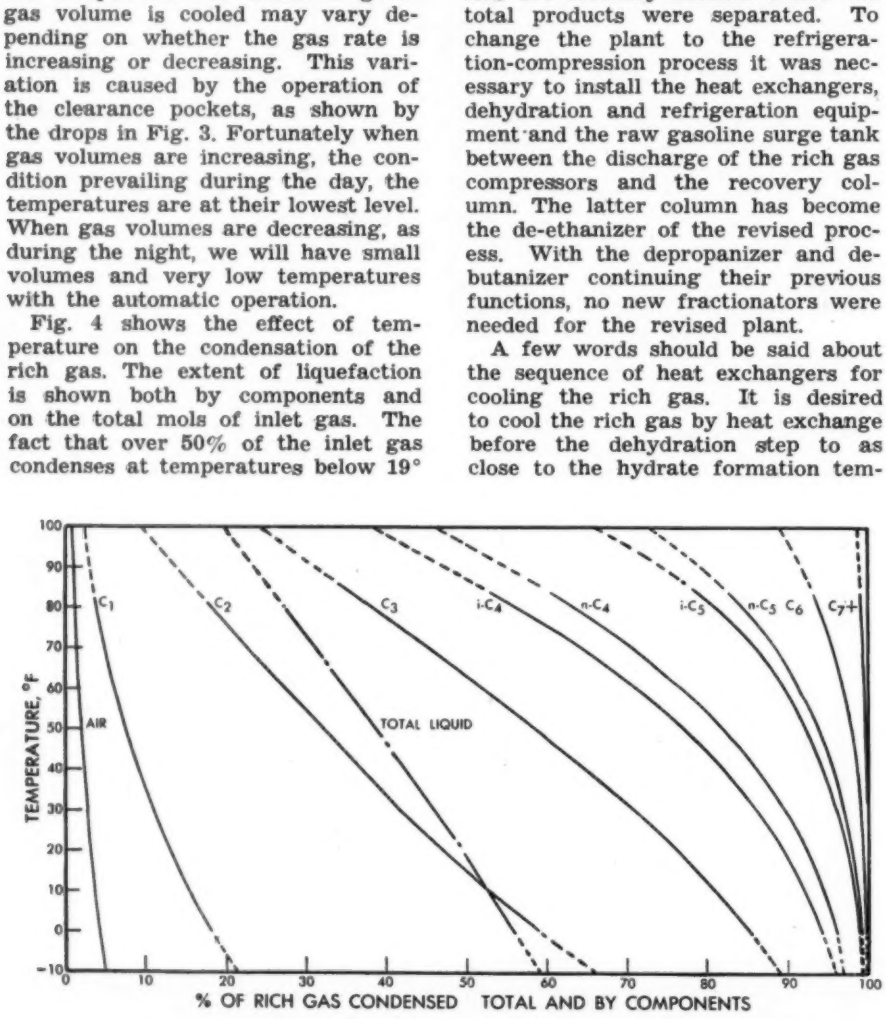
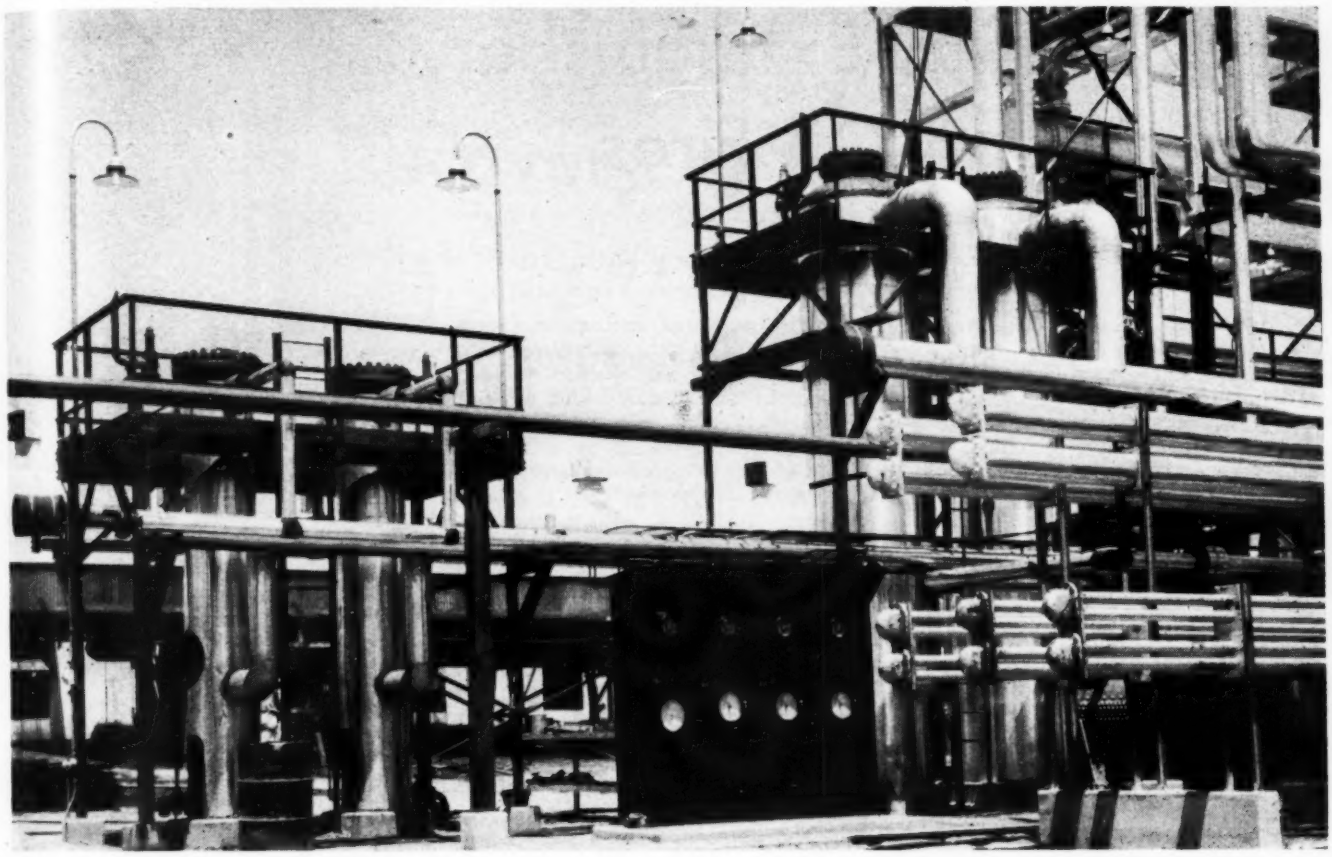


Fig. 4—Effect of temperature upon Sabine rich gas condensation at 265 psia.



Solid desiccant dehydration units installed at Magnolia's expanded Sabine gasoline plant. Liquid units are on left, gas units on right

fer surface. The deethanizer reflux condensers contain 1,400 sq. ft. of heat transfer surface.

The de-ethanizer has an ID. of 60 in. and 24 trays on 18-in. spacing. The depropanizer is 42 in. ID., and has 30 trays on 18-in. spacing. The debutanizer is 66 in. ID. and also has 30 trays on 18-in. spacing.

For an inlet gas load of 8,000 MCFD the calculated process water cooling load is about 20,000,000 Btu per day and the water circulation rate about 2,300 gpm. The cooled process water has a temperature of 87° F. The plant steam load is about 15,000 lb. per hr. The total electrical generation load is about 250 KW.

Auxiliary Work

In the original plant all process water and engine water circulation pumps were driven by non-condensing steam turbines. These have all been replaced by electrically driven centrifugal units. Three 1,650-gpm. vertical pumps each driven by a 75-hp. motor are provided for the process water. Three 1,000-gpm. horizontal pumps each powered by a 40-hp. motor are provided for the engine water. One each of the pumps act as standby units.

A new boiler feed water and condensate return system has been installed. With it almost 90% of the generated steam is returned as condensate. The uncondensed steam is utilized to preheat and de-aerate the raw make-up water. With the exception of a steam-driven standby pump, all boiler feed water pumps are electrically driven. By replacing the various steam-driven water pumps it has been possible to salvage two of six locomotive type boilers. The remaining four boilers operate with a load slightly over 100%. The generated steam pressure is 175 psig.

The new electric generator station contains three 157-KVA generators, each driven by a 165-hp. gas engine. The generated electricity is 440 volts, 3 phase and 60 cycles. Each unit has an individual water pump that is belt driven by the same engine to cool the engine jackets. The total generator engine water is cooled in a closed system utilizing shell-and-tube heat exchangers.

Water wells which were previously produced by gas-lift have been provided with electrically driven deep well pumps.

A 400 gpm. fire pump powered by a combination gas-gasoline engine has been installed for protecting the plant and adjacent property. A 6-in. line for fire hydrants loops the plant and has an extension to protect housing of employes.

Silencers have been installed on the exhausts of all compressor engines. Three monorail hoist systems have been added in the compressor room to increase maintenance efficiency. A 2-ton system extends over the engine heads and 3-ton systems are over the flywheels and compressor cylinders.

Process engineering work for the plant revision and procurement of major equipment were done by the Magnolia Petroleum Co. Delta Engineering Corp., Houston, handled the construction program.

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J. C. Vandaveer prepared the various flowsheets and curves.

Dry Chemical Extinguisher Effective on Oil Fires

By W. E. MORGAN, Jr.

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AMONG the more effective means for fighting refinery fires of many types is the dry chemical type extinguisher. Since the earliest use of dry chemical in the 1920's, fire fighting engineers have recognized its effectiveness against flammable liquid and fluid fires. However, in its original form—packaged for hand-throwing at fires—its usefulness was impaired because it caked in ineffectual lumps and was difficult to place on a fire without serious risk to the fire-fighter.

Today, hand extinguishers are manufactured which can be depended upon to shoot a stream of dry chemical from a safe distance directly at the seat of a fire that may be generating powerful updrafts of heat.

Three elements embodied in successful operation of dry chemical extinguishers are:

1. A fine, moisture-resistant powder.

2. A dependable, safe means of pressurizing the powder chamber and expelling the dry chemical without interruption.

3. A nozzle that discharges the dry chemical in a fire-covering pattern with sufficient force to reach the seat of a roaring blaze, but not with so much force that it splashes burning liquid and spreads the fire.

That the right combination of these elements provides a new measure of fire-fighting efficiency and safety was demonstrated recently at the Kidde proving grounds in Belleville, N. J., before a group of industry, municipal, and government representatives.

A dry chemical extinguisher consists essentially of a cylindrical metal container for the chemical—chiefly sodium bicarbonate—and a small cartridge of inert gas—carbon dioxide—which is released by a trigger into the larger container and forces the powder out through the nozzle. A cut-away view of a dry chemical hand extinguisher is shown in Fig. 1.

To show the penetrating power of dry chemical at the Belleville demonstration, Kidde engineers had rigged a simulated propane gas pipe line. Propane in liquid form was piped from storage tanks under 120 psi. pressure to a cracked flange at the end of the line. A hand valve in the 1½-in. line controlled the flow.

Ignited with a spark-gap lighter, then released in full pressure, the propane shot flames 30 ft. in the air and sent out heat waves that made approach closer than 20 ft. nearly impossible, without protective clothing.

When the blaze reached its peak intensity, a man in an ordinary business suit attacked the fire with a 20-lb. capacity dry chemical hand extinguisher. Within six seconds after he pulled the trigger and started discharge of a dense, swirling cloud of dry chemical through a parabolic path right into the flames, the fire was out.

Following this, the dry chemical extinguisher was demonstrated on oil and gasoline spill fires and on fire in oil escaping from a ruptured transformer. In spite of a brisk wind which fanned the blaze and which would cut down the fire-killing power of other agents, the dry chemical unit snuffed out a 400 sq. ft. gasoline spill fire in less than 18 seconds. Against the transformer fire (which might have been a leaking oil tank), complete extinguishment was even quicker.

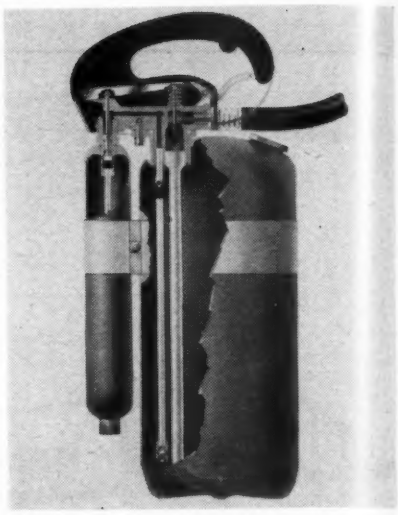

Fig. 1—Cutaway view of new dry chemical type fire extinguisher. Trigger at front end of the carrying handle actuates two valves simultaneously, one to open line from powder chamber to discharge hose, the other to open the smaller cylinder, which contains carbon dioxide under high pressure

The ability of the dry chemical to extinguish flames exists principally on its property of absorbing heat from the fire. There is a secondary effect of smothering, caused by liberation of inert gas—CO_2—when the sodium bicarbonate decomposes partially in the fire. The heat absorption property also is a boon to the fire-fighter because it serves as an insulating screen to shield him as he moves in on the fire. With such protection the operator can remain in an erect positon. This permits him to direct the dry chemical stream more accurately and to watch his progress against the blaze.

The dry chemical stream, driven by the force of carbon dioxide under pressure, has enough mass and momentum to overcome updrafts of heat and reach the heart of the fire almost instantly. Dry chemical also has some residual effect in preventing reflash, especially when used on fires in shallow liquid areas, on very heavy liquids, and on certain fibrous materials. Another advantage of the chemical is that it is a non-conductor of electricity, and a recommended agent for electrical fires.

The limitations on dry chemical restrict its use indoors where the fine powder might damage delicate machinery and equipment, or in areas where it might contaminate paints, chemicals, and the like. These are no handicaps, however, in combating outdoor refinery fires where dust is ordinarily not a serious problem.

Demonstrator uses hand extinguisher against a running oil fire from a ruptured transformer

Short Cut Process Design to Increase Propane Recovery in Gasoline Plants

By ALAN S. GLENDENING and CHARLES F. SANDERSON
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Article 8: Gas Fractionation, Calculations

In the previous article of this series (August, pp. 893-897), the authors discussed gas fractionation as applied to natural gasoline and cycling plant operations. This process consists of recovering the valuable constituents in natural gas by low temperature fractional distillation rather than by contacting the gas with absorption oil. Flow diagrams of the process were shown and the effect of various operating variables discussed. This month the authors explain the methods of calculation involved in the design of gas fractionating facilities, with examples.

THE only serious calculation problem lies in the recovery tower design which, although treated by well known fractionator procedures, must be conducted with great care and a proper safety factor employed. Improper design would result in a failure of the plant to achieve the desired recoveries, or alternatively could unnecessarily increase the plant cost.

The calculation of a recovery tower by any of the usual short-cut procedures is likely to result in serious error. This is true because in a tower of this type, handling a wide range of components, a very considerable variation in relative volatilities and in molal latent heats will be encountered. In particular, the relative volatility of the key components, ethane and propane, which at high pressures is fairly constant above 100°, undergoes a rapid change with variations in temperature below 100°. The generally accepted short-cut methods assume constant molal latent heat (constant molal overflow) above and below the feed point. Some of them also assume constant relative volatilities throughout the tower.

Consequently, the only thoroughly satisfactory method of recovery tower computation is a rigorous tray-by-tray calculation with heat balances taken at every tray. This is, of course, extremely tedious, but worthwhile, considering the critical importance of the recovery tower to the process.

Meanwhile, some short-cut method is necessary for preliminary cost estimating, for comparing operation at various operating pressures and/or extraction rates, and to give a reflux figure with which to commence detailed tray-by-tray computations. Such a method will be demonstrated in a sample calculation and is as follows:

As was mentioned previously, a recovery tower normally operates nearly as if it had an infinite number of trays. Therefore the procedure is to establish feed conditions and then compute the minimum reflux corresponding to infinite trays by one of the several accepted procedures. The most convenient method is that of Underwood[1]. The main difficulty in using this method is in properly choosing the average tower temperature corresponding to the relative volatilities to be inserted in Underwood's equations. In the highly accurate method of Colburn[2] this problem does not arise since the proper relative volatilities are developed during the course of the calculation. However, if the feed condition is such that mols of liquid in the feed approximately equal the mols of bottom product, relative volatilities at this feed condition inserted in Underwood's equations seem to give good agreement with the Colburn method. In the sample calculation, Underwood's method will be employed accordingly.

The calculated minimum reflux will be increased by about 10% to allow for the fact that the tower contains a finite number of trays. An additional 20% will be added to allow for column flexibility and approximations in the method. It will be assumed that this amount of reflux must be available as internal reflux directly above the feed. External reflux and condenser load will then be calculated on the assumption that the internal reflux and vapor directly above the feed is at the feed temperature, but that the internal reflux is somewhat lighter than the liquid portion of the feed.

It should be noted that this preliminary design method is likely to be conservative over and beyond the 20% safety factor that was used in arriving at internal reflux above the feed. Because of varying molal latent heats, the average liquid-to-vapor ratio above the feed will be greater than it is near the feed; similarly, the average vapor-to-liquid ratio below the feed will be greater than it is near the feed. Both of these facts act to reduce the number of trays required at any reflux rate and tend to introduce an additional safety factor into the method. Because of the critical importance of the recovery tower operation, however, an overall safety factor of somewhat greater than 20% is not undesirable.

Nothing has been said so far about butane losses. For propane recoveries in excess of 50 or 60%, butane losses may be safely ignored. For lesser recoveries, butane losses may become appreciable and may be computed during the course of a tray-by-tray calculation. Such losses only slightly affect the minimum reflux calculation which is dependent mainly on the relative amounts of ethane and propane in the tops and bottoms, gas composition, and ethane-to-propane relative volatility.

In setting up the operating conditions of the tower, care must be taken to operate below the critical conditions of the bottom product.

Sample Calculation

20,000,000 standard CFD of a gas is to be processed in a gas fractionation plant for the recovery of 60% of the propane and substantially all of the butanes and heavier. Residue gas is to be discharged from the plant at slightly less than 500 psig.

A propane refrigeration system is to chill the feed and condense reflux. A 3% (mol basis) inclusion of ethane in propane is to be allowed. The gas composition is as follows:

Component	Mol%
Methane	69.0
Ethane	12.0
Propane	9.0
i-Butane	1.5
n-Butane	4.5
i-Pentane	1.0
n-Pentane	1.7
Hexane+	1.3
	100.0

Basis of fractionation calculations will be 100 mols/hr. of wet gas. MIT K's will be used throughout.

Propane recovered = (0.6)(9.0) = 5.4 mols/hr. and ethane in the bottoms = (0.03)(5.4) = 0.16 mols/hr.

TABLE 22—Calculation of Pseudo-Critical Pressure of Bottoms

	Bottoms, Mols	Crit. Press., psia.	(Mols) (Crit. Press.)
Ethane	0.16	708	110
Propane	5.40	617	3340
iso-Butane	1.50	530	790
n-Butane	4.50	551	2480
iso-Pentane	1.00	482	480
n-Pentane	1.70	485	830
Hexane +	1.30	397	520
	15.56		8550

In Table 22, the analysis of the bottoms is given and its pseudo-critical pressure determined by the molal averaging method. It is 8550/15.56 = 550 psia.

In Table 23, the reboiler outlet temperature is found to be 265° by a bubble point calculation, and the pseudo-critical temperature of the bottoms is determined by the molal averaging method. It is 4606/15.56 = 296° F.

The actual critical conditions will be somewhat higher than the pseudo-critical conditions, so 500 psig. operation will be satisfactory.

Since the total mols of bottoms is 15.56, feed conditions will be established so that the liquid portion of the feed will be approximately this amount. This calculation is performed in Table 24 by the usual equilibrium method. At 45° it is found that 15.2 mols of feed will be liquefied, so this will be the feed temperature. Total enthalpy of vapor and liquid at the feed is found to be 622,000 Btu/hr.

Although the calculation is not shown, it may be determined that there are 917 lbs./hr. of bottom product, or:

Bottoms mol wt. = 917/15.56 = 59.0 (272 Btu./lb.)

Bottoms enthalpy = (917)(272) = 249,000 Btu./hr.

Reflux temperature is determined in Table 25 by computing the dew-point of the residue gas. This calculation also gives the reflux composition and mol wt., and the enthalpy of residue gas. Reflux will be condensed at −22° F and the enthalpy of residue is 423,000 Btu./hr.

The equations of Underwood for minimum reflux ratio[1] are as follows (with certain changes from the original nomenclature):

$$(R_d)_{\min.} + 1 = \Sigma[\alpha y_d/(\alpha - \theta)] \quad (1)$$

where θ is given by:

$$\Sigma[\alpha z_f/(\alpha - \theta)] = 1 - q \quad (2)$$

where:

- R_d is reflux ratio relative to overhead (residue).
- α is relative volatility with respect to some reference component.
- y_d is mol fraction of any component in overhead.
- z_f is average mol fraction of any component in the feed.
- q is thermal condition of feed, defined by $q = (L_m - L_n)/F$, where L_m and L_n are total mols liquid below and above the feed respectively, and F is total mols of feed.
- θ is the root of Equation 2 whose value lies between the α's of the key components. (Equation 2 has as many roots as there are components in the feed).

According to the definition of q given above, q will be given approximately by the fraction of the feed which is liquid. Therefore, q = 15.2/100 = 0.152, or $1 - q$ = 0.848.

θ must be solved from Equation 2 by trial and error, and lies between the α's of the key components. The relative volatilities will be taken relative to propane and at the feed conditions. The solution of the above equations is given in Table 26. Minimum reflux ratio is 1.158 − 1.0 = 0.158. Assuming this ratio to be available internally and directly above the feed point, liquid down flow directly above the feed will be: (0.158)(84.44) = 13.34 mols/hr. Adding 10% to allow for a finite number of trays and 20% safety factor, liquid above the feed point is (1.1)(1.2)(13.34) = 17.6 mols/hr. This internal reflux will be somewhat lighter than the liquid portion of the feed (49.0 mol wt.), so we'll assume 40 mol wt. internal reflux.

Based on the above calculations, the reflux condenser duty is determined in Table 27 and is 156,000 Btu./hr. In Table 28, the assumption that this corresponds to 24 mols/hr of *external* reflux is checked and found correct. Vapors enter the reflux condenser at +17° F.

TABLE 23—Calculation of Reboiler Temperature and Pseudo-Critical Temperature of Bottoms

	Bottoms Mols	K at 265° and 500 psig.	(mols) (K)	Critical Temp. °F.	(Mols) (Crit. Temp.)
Ethane	0.16	3.3	0.53	90	14
Propane	5.40	1.48	7.99	206	1112
iso-Butane	1.50	.95	1.42	273	409
n-Butane	4.50	.87	3.92	306	1377
iso-Pentane	1.00	.58	0.58	370	370
n-Pentane	1.70	.49	0.83	387	657
Hexane +	1.30	.2	0.26	513	667
	15.56 mols		15.53		4606

TABLE 24—Calculation of Feed Temperature and Enthalpy

At $(L/V)_{feed}$=0.18, L_{feed} = 0.18)(100)/1.18=15.3 mols. Assume a feed temperature of 45°, then:

	Feed Mols	K @ 45° and 500 psig.	Feed Liq. Mols	Feed Liq. Lbs.	Feed Vap. Mols	Feed Vap. Lbs.
Methane	69.0	4.15	2.9	46	66.1	1060
Ethane	12.0	.88	2.0	60	10.0	301
Propane	9.0	.327	3.2	141	5.8	256
iso-Butane	1.5	.147	0.8	46	0.7	41
n-Butane	4.5	.107	2.8	163	1.7	99
iso-Pentane	1.0	.042	0.8	58	0.2	14
n-Pentane	1.7	.032	1.4	101	0.3	22
Hexane +	1.3	.0033	1.3	130	...	...
	100.0 mols		15.2 mols	745 lbs.	84.8 mols	1793 lbs.

where Feed Liq. $= \dfrac{(L/V)_{feed}}{K + (L/V)_{feed}}$ (total mols component). The computed value of the liquid portion of the feed (15.2) checks well with the assumed value (15.3), so 45° is correct as feed temperature. At feed, 45°:

Liquid mol wt. = 745/15.2 = 49.0 (128 Btu./lb.)
Vapor mol wt. = 1793/84.8 = 21.2 (294 Btu./lb.)
Liquid enthalpy = (745)(128) = 95,000 Btu./hr.
Vapor enthalpy = (1793)(294) = 527,000 Btu./hr.
Total enthalpy at Feed = 622,000 Btu./hr.

TABLE 25—Reflux Temperatures

	Residue Gas. mols	Res. Gas Lbs.	K @ −20° and 500 psig.	Mols/K, or Reflux Comp.	Times Mol Wt.
Methane	69.00	1106	2.66	25.93	416
Ethane	11.84	356	.468	25.30	761
Propane	3.60	159	.113	31.85	1406
	84.44 mols.	1621 lbs.		83.08	2583lbs.

−20° is not quite correct. At K of ethane = (83.08)(.468)/84.44 = .46, temperature is −22°, so this is the reflux temperature. Since the summation of residue divided by K gives reflux composition, then at the reflux accumulator (−22°):

Reflux mol wt. = 2583/83.08 = 31.1 (106 Btu./lb.)
Residue mol wt. = 1621/84.44 = 19.2 (261 Btu./lb.)
Residue enthalpy = (1621)(261) = 423,000 Btu./hr.

Determine reboiler load by a heat balance around the entire tower system:

Out:	Residue Gas:	423,000 Btu./hr.
	Bottoms:	249,000
	Condenser:	156,000
	Total Out:	828,000 Btu./hr.
In:	Feed:	622,000 Btu./hr.

Reboiler Load = 828,000 − 622,000 = 206,000 Btu./hr.

All the above results, which are based on 100 mols/hr. of feed, are summarized in Fig. 32. The gas chiller load, computed later, is also shown on the same basis. Reboiler vapors have not been computed, since, for the purposes of this preliminary calculation, tower diameter will be determined by vapor loading in the rectifying section only.

Tower Sizing:

Actually, the required tower diameter should be computed both at the top of the tower and just above the feed. However, it turns out that loading conditions at these two points are substantially the same, so only the calculations applying to the top will be shown. Liquid density at the top tray is computed from the molal composition given in Table 28 as follows:

	Molal Comp. of Liquid	Lbs.	Gals
Methane	23.0	369	147
Ethane	28.6	860	276
Propane	61.5	2715	640
	113.1	3944	1063

or lbs./gal. = 3944/1063 = 3.71 at 60°. By interpolation on a hydrocarbon fluid density chart[3], density at 17° is found to be 4.03 lbs./gal. or (4.03)(7.48) = 30.2 lbs./cu. ft.

Vapor density at top tray (21.8 mol wt.) is (21.8/379)(520/477)(515/14.7) = 2.20 lbs./cu. ft.

Quantities must now be increased from the 100 mol/hr. basis to a 20,000,000 SCFD basis. The multiplier which will accomplish this is (110)(20)/100 = 22.0 (1,000,000 SCFD = 110 mols/hr.). Therefore, lbs. vapor off top tray = (22.0)(2367) = 52,100 lbs./hr.

The method of Souders and Brown[4] will be used. It has been developed for conditions where entrainment is limiting and may be used for computing tower diameter wherever liquid loading is not extremely high compared with vapor loading. The Souders and Brown equation revised for direct solution of the diameter[5] is:

$$(D_{min})^2 = \frac{4}{\pi} \frac{V_w}{C[\rho_v(\rho_L - \rho_v)]^{1/2}}$$

where:

D_{min} is minimum tower diam., ft.

V_w is vapor loading, lbs./hr. = 52,100.

ρ_v is vapor density, lbs./cu. ft. = 2.20.

ρ_L is liquid density, lbs./cu. ft. = 30.2.

TABLE 26—Minimum Reflux

Sum up the left hand terms of Equation 2 by assuming $\theta = 1.5$:

	α @ 45° and 500 psig.	z_f	αz_f	$\alpha - \theta$	$(\alpha z_f)/(\alpha - \theta)$
Methane	12.7	0.690	8.76	+11.2	+0.782
Ethane	2.69	0.120	0.323	+ 1.19	+0.271
Propane	1.0	0.090	0.090	− 0.50	−0.180
iso-Butane	.45	0.015	0.00675	− 1.05	−0.006
n-Butane	.327	0.045	0.0147	− 1.173	−0.013
iso-Pentane	.128	0.010	0.00128	− 1.372	−0.001
n-pentane	.098	0.017	0.00167	− 1.402	−0.001
Hexane +	.01	0.013	0.00013	− 1.49	−0.000
		1.000			+0.852

The computed summation checks well with $1 - q = 0.848$, so $\theta = 1.5$ is very nearly correct. Substituting in Equation 1:

	y_d	αy_d	$(\alpha y_d)/(\alpha - \theta)$
Methane	0.8172	10.38	+0.926
Ethane	0.1402	0.377	+0.317
Propane	0.0426	0.0426	−0.085
	1.0000		1.158

or $(R_d)_{min} = 1.158 - 1.0 = 0.158$

C is a function of liquid surface tension and tray spacing. From a chart[3], surface tension is found to be less than 10 dynes/cm. So, from the Souders and Brown correlation chart[4, 5], C = 450 for 18-in. tray spacing. Substituting:

$$(D_{min})^2 = \frac{4}{\pi} \frac{52{,}100}{450[2.2(30.2 - 2.2)]^{1/2}} = 18.8$$

or:

$$D_{min} = (18.8)^{1/2} = 4.34 \text{ ft.}$$

Applying a 25% safety factor based on vapor loading, diameter is 4.34 $(1.25)^{1/2}$ = 4.85 ft. Use a 5-ft. diameter tower with 18-in. tray spacing.

Utilities are obtained by multiplying the previously computed values by 22.0, or:

Reflux = (24)(22.0) = 528 mols/hr.

Condenser load = (22.0)(156,000) = 3,430,000 Btu./hr. = 286 tons of refrigeration.

Reboiler load = (22.0)(206,000) = 4,530,000 Btu./hr.

It is recommended that a 30-tray tower be used since the propane recovery is fairly high.

With regard to refrigerating the chiller and reflux condenser at different levels, note the following points from the propane saturation curve:

Reflux condenser	−32°	19.4 psia.
Feed Chiller	+35°	72.0 psia.
Refrigerant Condenser	+100°	187.0 psia.

With 85° water available, the above refrigerant conditions will allow a 10° temperature approach in the two refrigerating units and a 15° approach in the refrigerant condenser. Now, allowing a 3 psi. drop from each refrigerating unit to compressor suction and a 5 psi. drop through the refrigerant condenser, suction and discharge pressures and compression ratios will be as follows:

1st Stage: 16.4 psia. to 69.0 psia, or 4.21 ratio
2nd Stage: 69.0 psia. to 192 psia. or 2.79 ratio

These ratios are, of course, considerably out of balance, but not so much so as to produce any serious increase in horsepower requirements. The above refrigerant conditions will,

TABLE 27—Reflux Condenser Duty

Lbs. internal reflux = (40)(17.6) = 704
Lbs. vapor above feed = 704 + 1621 = 2325
Mols vapor above feed = 17.6 + 84.4 = 102.0
Mol wt. internal reflux = 40 (135 Btu./lb. at 4°°)
Mol wt. vapors = 2325/102 = 22.8 (290 Btu./lb. at 45°)

Heat balance around rectifying section, condenser, and reflux tank:

In: enthalpy of vapor above feed = (2325)(290) = 674,000 Btu./hr.

Out: enthalpy of internal reflux = (704)(135) = 95,000 Btu./hr.
enthalpy of residue gas (previously given) = 423,000 Btu./hr.

Total out: 518,000 Btu./hr.

Condenser duty = 674,000 − 518,000 = 156,000 Btu./hr.

TABLE 28—External Reflux

Assume 24 mols./hr. of external reflux (composition given in Table 25):

	Ext. Refl. Mols	Total Vapor to Cond., mols	K @ + 12° and 500 psig.	Total mols/K
Methane	7.49	76.49	3.32	23.0
Ethane	7.31	19.15	.67	28.6
Propane	9.20	12.80	.208	61.5
	24.00	108.44		113.1

At K of ethane = (.67)(113.1)/108.4 = .70, temperature is +17°, so material enters condenser at this temperature.

Lbs. external reflux = (24)(31.1) = 746
Total lbs. to condenser = 746 + 1621 = 2367
Mol wt. of material to condenser = 2367/108.4 = 21.8
Btu./lb. of material to condenser at 17° = 277
Enthalpy of material to condenser = (2367)(277) = 655,000 Btu./hr.
Enthalpy of external reflux = (746)(106) = 79,000
Enthalpy of residue gas = 423,000
502,000 Btu./hr.

Condenser duty corresponding to 24 mols./hr. of reflux is, therefore, 655,000 − 502,000 = 153,000 Btu./hr. This checks well with the previously determined condenser load, so the assumed reflux is correct.

therefore, give satisfactory results.

Although we will not present the calculation of refrigeration horsepower required for this plant (such a calculation was performed in Article 4 of this series), it will be of interest to determine the tonnage of refrigeration required. Cost estimating figures on refrigeration systems are generally given in dollars per ton for given depths of refrigeration.

The reflux condenser refrigeration load has been determined to be 286 tons. Only the charge chiller load remains to be computed. Assume the total charge enters the process area at 90° and its temperature is to be reduced to 45° at the recovery tower feed. Enthalpy of feed at 45° (20,000,000 SCFD. basis) is (622,000) (22.0) = 13,680,000 Btu./hr. In Article 4 of this series, the same gas was found to be partially condensed at 90° and 500 psig. and had an enthalpy of 16,340,000 Btu./hr. The heat to be extracted from the gas when chilling from 90° to 45° is then: 16,340,000 − 13,680,000 = 2,660,000 Btu./hr. Part of this chilling may be obtained by countercurrent heat exchange with cold residue gas from the recovery tower reflux tank. This gas is available at −22°; assume it will be heated up to +70° by exchange, or the terminal temperatures are:

feed: 90° → ?

residue: 70° ← −22°

The outlet temperature of the feed need not concern us here; suffice to say that it turns out to be in the vicinity of 60°. The heat duty of the exchanger is that required to raise the temperature of the residue gas from −22° to 70°. Residue gas (19.2 mol wt.) amounts to (1621) (22.0) = 35,700 lbs./hr. (20,000,000 SCFD. basis).

At 70° & 500 psig, Btu./lb. = 313
At −22° & 500 psig, Btu./lb. = 261

Difference, Btu./lb. ..... = 52

Heat exchanger duty = (52) (35,700) = 1,860,000 Btu./hr.

The chiller duty is that duty remaining after the feed has been partially chilled in the exchanger, and is: 2,660,000 − 1,860,000 = 800,000 Btu./hr., or 67 tons of refrigeration. The total load on the refrigeration system then is: 67 + 286 = 353 tons, of which 67 tons are applied by chilling hydrocarbons to +45° and 286 tons by chilling to −22°.

Total plant production (calculation not shown) will amount to 100,000 gallons per day of which about half will be butane and propane and half natural gasoline.

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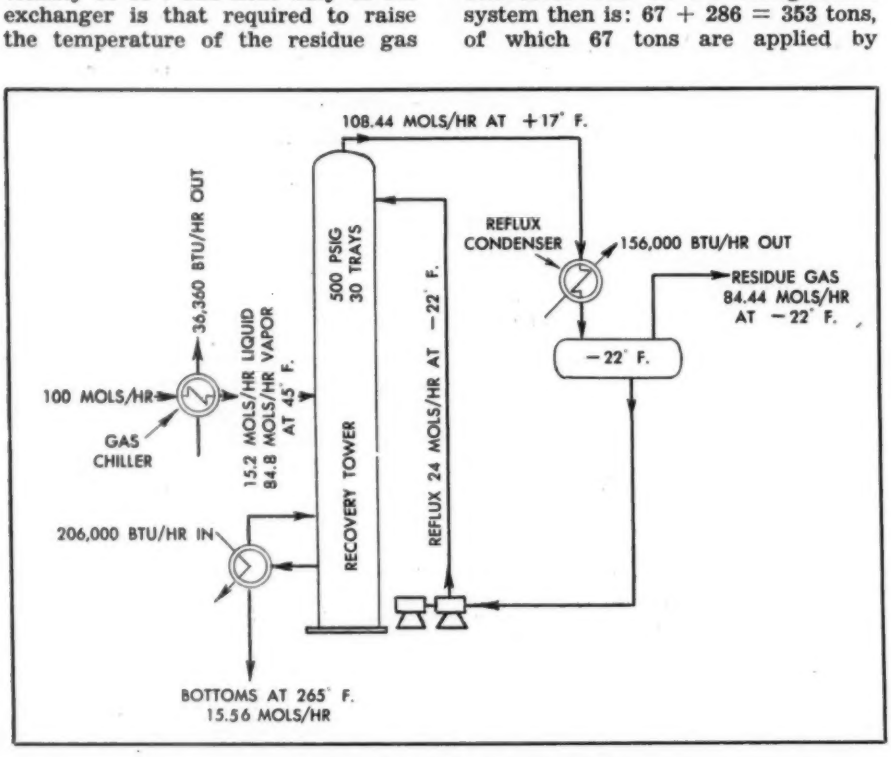

(Basis: 100 mols/hr. wet gas feed)

Fig. 32—Computed Recovery Tower Quantities

Concluding Remarks on this Series

During this series we have discussed:

(a) Rich oil de-ethanization—a means of removing undesirable light vapors at an early point in an oil absorption plant, and thereby reduce non-condensible still vapors.

(b) Refrigerated oil absorption—a means of maximizing extraction rates in a main plant absorber without increasing oil circulation or operating pressure. Also discussed was the fractionating de-ethanizer column, a tower that eliminates undesirable light components that would otherwise contaminate propane production.

(c) Multi-stage absorption oil distillation—a means of reducing non-condensible still vapors by obtaining the equivalent of high pressure single still operation without increase of utilities.

(d) Gas fractionation—a method of recovering valuable constituents of natural gas by refrigeration rather than oil absorption.

It may be desirable to combine some of these operations in a single plant. For instance, it was shown in one of the sample calculations that high propane recovery with refrigerated oil absorption requires a very large recompressor installation if a conventional oil distillation system is employed. If the same rich oil is processed in a two-stage distillation system, recompressor vapors (non-condensible still vapors) may be greatly reduced. In the sample calculations, a 300 H.P. recompressor was required with conventional distillation, whereas only 25 H.P. was needed after two-stage distillation.

The rich oil de-ethanizer also may be used to reduce recompressor vapors. Thus, for extremely high extraction rates involving the treatment of wet gases containing an abnormally high proportion of propane, it becomes desirable to combine operations (a), (b), and (c) in a single plant.

Gas fractionation is, of course, an entirely different process and cannot readily be combined with any of the operations described above.

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Sulfurized Extreme-Pressure Lubricants And Cutting Oils

—Part 1, Literature Survey

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This paper is a survey on the general subject of sulfurized oils and sulfur compounds, with particular reference to the use of such materials in extreme-pressure lubricants and cutting oils. The present survey covers the important contributions published in the English language up to 1948, with a few pertinent references from the foreign literature.

Since the functioning of these lubricants is largely dependent upon their behavior under "boundary lubrication" conditions, the theoretical background of boundary lubrication, as known today, is presented along with the theories on the mechanism of the lubrication process using sulfurized lubricants.

Because of the similarity in lubricating conditions wherever high pressure prevails (in cutting and drawing operations, in certain types of gears, and sometimes in bearings) the theoretical presentation is based primarily on the literature of extreme-pressure lubricants in general, with just a few references to the specific problems encountered in cutting operations.

IT has been well established that, depending largely on the pressures involved, there are two types of lubrication, namely, fluid lubrication and boundary lubrication. In fluid lubrication, two sliding metal parts are completely separated by an oil film and the laws of hydrodynamics are followed. Friction mainly depends on the viscosity of the lubricant; the coefficient of friction is usually expressed as a function of viscosity, speed, and pressure.(25, 81, 94) As pressure is increased, the oil is forced out and metal to metal contact may develop and cause a sudden increase in the coefficient of friction. In this case the phenomenon known as "wear" will develop, being manifest in the removal of metal particles from the surface. The sudden increase in friction and the appearance of wear are characteristic of the region of boundary lubrication.

Between the region of complete lubrication and that of "partial" or boundary lubrication there is a transient region referred to as the "location of the critical point" by Wilson and Barnard(94) and as "semi-fluid friction" in German literature.(91) Beeck and collaborators(6) called it "quasi hydrodynamic lubrication" and gave a very thorough explanation for the phenomenon occurring in this transitory region. It is well known that, in the region of boundary lubrication, a thin film adsorbed on a metal surface may serve as a lubricant and separate two sliding metal parts. In nature, these boundary films may be very different, their only common characteristic being that they are all extremely thin; sometimes they do not surpass in thickness that of a monomolecular layer. Organic polar compounds; oxide, sulfide and chloride films; contamination; impurities; gases; water vapor—all may have some part in preventing metal-to-metal contact in the boundary region.

Theoretical Considerations

The Law of Friction. Considerable effort has been concentrated on the development of a proper interpretation of the law of friction, as formulated by Amontons(2) and Coulomb(26), which stated that the frictional force observed on sliding surfaces is proportional to the load and independent of the area of the sliding surfaces.(13, 43) The coefficient of friction was defined as the ratio of the tangential resistance to the normal component of the load. In the region of boundary lubrication, it has been found to be independent of the sliding velocity and the viscosity of the lubricant. It depends, however, on the composition and the nature of the surfaces and on the nature of the lubricating film if such be present.(25, 48)

It has long been known that even the smoothest metal surface has many irregularities in the form of microscopic hills and valleys. In modern concept the term "area" has therefore two meanings with respect to sliding metal surfaces: (a) apparent surface area, and (b) actual contact area where the protruding irregularities meet. In 1939, Bowden and Tabor(15) showed by conductivity experiments that under a light load the area of contact of two sliding surfaces was about 1/170,000 of the apparent area. With increasing load the contact area increased, but it still remained almost negligible compared to the apparent area.

Bowden, Moor, and Tabor(13) referred to the Amontons Coulomb law of friction as it was presented in Hardy's papers(43) and limited its meaning with respect to "area" and "load". In investigating metal surfaces using the so-called "taper-sectioning" method of Nelson(66), they found that, when the area of actual contact is constant, the frictional forces are also constant and independent of the load or pressure. According to this concept, the frictional resistance is determined exclusively by the area of actual contact and is influenced by the load only insofar as the load changes the area of contact. Increasing load increases the actual contact area by causing plastic deformation (the so-called plastic flow) of the already existing points of contact.(7) In this way lower areas of the surface will be reached. With increased contact area, more force is required to overcome friction; the increased frictional force is proportional to the increased contact area and, hence, indirectly proportional to the load.

Prutton and collaborators(70) questioned why friction does not stay constant after such plastic deformation when loads are diminished. It would be expected from Bowdon's interpretation that friction would not decrease with decreasing pressure. This is not the case, however; the frictional resistance — proportionally

decreasing with diminishing load—is in full conformance with the laws of Amontons and Coulomb. Prutton[70] mentioned the possibility of a total rearrangement of contact points with decreasing pressure.

Friction and Wear. The origin of friction is attributed either to the geometrical interference of the many small roughnesses on the rubbing surfaces, or to strong, attractive molecular forces. The latter concept is the more modern. Tomlinson[85], Hardy[43, 44] and others[70, 88] discussed the origin of friction with references to molecular adhesion between two surfaces at the points where they come into intimate contact. Adam[1] showed that the forces of molecular attraction at surfaces 1 to 2 Angstrom units apart may be strong enough to cause welding of the two metal surfaces. Thus, under high load, welding of the high points will occur.

According to the molecular attraction theory, the force necessary to overcome friction and start motion is equal to the sum of the force necessary to overcome molecular attraction and the force necessary to break all the minute local welds. The sliding movement of metal surfaces tears off the weldings instantaneously. The process of welding and tearing off is repeated constantly and causes wear, which is a characteristic of boundary lubrication. In the case of different metals, after the weld is broken, a small part of the softer metal adheres to the harder one. The high temperatures caused by friction sufficiently soften even hard metals to bring about shear, which leaves large areas of one metal adhering to the other. This process is known as "galling." Wear and friction are inseparable in the region of boundary lubrication, but no functional correlation has been found between these two factors. Of course, wear of this type cannot occur in the region of fluid lubrication, where a fluid film permanently prevents metal-to-metal contact.[48]

The "tearing and ploughing" of metal surfaces due to friction was described and well illustrated by Bowden, Moor, and Tabor.[13] The depths and heights caused by the ploughing action of sliding metals were found to be up to 10^{-3} cm. in magnitude. As pressure increases, the contact area will increase and welding of relatively large areas will take place. This process is known as "seizure" and results in total failure.

Reduction of Friction and Wear. Bowden and his collaborators studied friction on unlubricated surfaces. The difficulties in obtaining truly clean surfaces were recognized; such surfaces were obtained only by mechanical abrasion. Bowden and Hughes[11] showed that the removal of contamination between metal surfaces by degassing in vacuo increased the coefficient of friction considerably. The constant presence of contaminants has a beneficial wear-reducing action[53], because it interferes with welding.

To reduce friction and wear and to avoid welding, the two sliding metal surfaces must be separated from each other. A thin film of a foreign material may serve as the barrier. It has been found by Rayleigh[72] and Hardy[43] that very thin adsorbed films are capable of reducing the coefficient of friction. Because the thickness of these films may be less than the dimension of the irregularities of the surface, it is more reasonable to assume that the reduction of friction in the boundary region is due to the barrier between the two attracting metal surfaces, rather than to the possible overcoming of surface irregularities.

Langmuir and Harkins independently revealed for the first time the physical behavior of extremely thin films, which later found ample application in boundary lubrication. In 1917, Langmuir[54] stated that fatty acids have a tendency to orient themselves on surfaces. In the same publication Langmuir referred to some work completed by Harkins along similar lines. The Langmuir theory assumes that fatty acid molecules are anchored to the surface by their carboxyl groups (the active groups). The film thickness is dependent upon the length of the hydrocarbon chain perpendicular to the surface. Such extremely thin layers adhere tenaciously to surfaces and can only be destroyed by heat or abrasion. It has been found that thin films of polar compounds in general cling tenaciously to metal surfaces, and remain even after the surface has been rubbed or washed in hot solvents.

Polar compounds by themselves or in solution may form boundary films under conditions of mild pressure. Heat developed under higher pressures may burn away such films. These films may also be ruptured by mechanical means. Extreme-pressure conditions, therefore, require lubricants which have inorganic ingredients capable of forming films which will not burn and which will withstand rupturing under high pressures and temperatures. It has been found that compounds containing "active" sulfur, or sulfur and chlorine in an active state, will give satisfactory performance under conditions of extreme pressure. The term "active" is used to designate those compounds which decompose at high temperatures with liberation of sulfur or chlorine, which in turn can react with clean polished metal.

Mechanism of Boundary Lubrication. The currently accepted theories of the mechanism of boundary lubrication were mainly worked out by Beeck, Davey, Prutton, and collaborators. In their work, equipment used to measure friction and wear was supplemented by the use of highly scientific methods for investigating boundary films by X-ray diffraction[16, 23], electron diffraction[17, 40, 62] and tracer techniques.[19] Clark, Starrett, and Lincoln[23] also used X-ray diffraction methods to substantiate orientation theories of boundary films, their work being based on previous investigations of Bragg[16] and Trillat.[86, 87] Methods for investigating thin films were also discussed by Germer[40] and Murison[62] and utilized by Beeck, Givens, and Smith.[6]

Beeck and coworkers[6] explained the concept of "wedging effect". They coated metal balls with an adsorbed boundary film and studied in the Boerlage four-ball machine[8] the changes in the coefficient of friction due to changes in velocity. When using certain types of boundary films they found that, with decreasing velocities, the coefficient of friction increased until a sudden increase occurred, beyond which the coefficient of friction became constant and independent of velocity; this phenomenon is characteristic of the boundary region. The velocity at which the sharp increase in the coefficient of friction occurred was defined as the "critical velocity." It was postulated that the low coefficient of friction at high velocities is due to some type of "oil drag" connected with surface activity, which causes the lubricant to "wedge" into the surface. It is evident that the wedging effect may occur only if there is material present that can be wedged in, as in the region of "quasi hydrodynamic" lubrication. Under true boundary conditions no wedging can be expected; Beeck and collaborators actually could not find any such effect when the test specimens were "well rubbed".

Larsen and Perry's[55] experiments confirmed that a lubricant must be present in the "quasi hydrodynamic" region. The electrical resistance between moving parts was found to be low under true boundary conditions, whereas above the critical velocity the resistance became very high—over 10,000 Ohms. Because of the high loads used, no true hydrodynamic conditions could exist; but the resistance was found to be as high as with a separating oil film. Changes in the physical properties—such as viscosity—of the lubricant were found to affect the critical velocity very little. In general, the wedging effect was obtained only with compounds having high polarity, although at room temperature some nonpolar compounds—such as sterone

and tetratriacontane—also showed wedging. At higher temperatures the non-polar compounds evaporated, whereas polar components still clung tenaciously to the metal.

With the introduction of the theory of "chemical polishing action" Beeck, Givens, and Williams[7] gave an entirely new concept of wear prevention. The experiments of Bowden and collaborators (as already discussed) definitely proved that the load is carried by relatively few protruding points on the metal surface. In consequence, the distribution of the load is very uneven—a condition which may lead to excessive wear*. It was found that tricresylphosphate is an efficient anti-wear agent. According to Beeck, its action is due to the formation with the base metal of low-melting eutectics, which formation leads to melting off of the high points of the surface. Thus the contact area increases, again the eutectic forms, and further melting takes place; the entire sequence resulting in a very thorough polishing action. The load is thereafter more evenly distributed, and wear decreases. The eutectic formed on iron by tricresylphosphate was found to melt at 1020° C. (515° C. below the melting point of iron). A eutectic mixture obtained with copper, Cu_3P, melted at 707° C. (376° C. below the melting point of copper). The strongest support thus far for the eutectic theory was the observation that tin, which does not form eutectic mixtures with phosphorus, does not show wear reduction when lubricated with mineral oil containing a phosphate additive. The authors included a table of M.P.-lowering eutectic mixtures containing As, Sb, P, Si, B, Ti, Ge, and Zn as additives and Ag, Au, Co, Cu, Mn, Pt, Ni, and Fe as base metals.

According to the same authors, in contrast to wear-reducing agents, extreme-pressure agents — which must have antiweld characteristics — are "corrosive" and will not form low-melting alloys with base metals. E. P. agents will therefore not cause any chemical-polishing action.

Wear and friction are not interrelated terms, and a friction-reducing agent will not necessarily reduce wear.[65] This assumption was supported experimentally by Larsen and Perry[55] and led to the conclusion that it is very difficult to reduce friction and wear at the same time.

Beeck and collaborators found that additives for boundary lubrication may be:

1. Wedging agents—mainly polar compounds—which reduce friction.

2. Chemical-polishing agents—inorganic constituents of organic compounds forming low-melting eutectics with the base metal—which reduce wear.

3. E.P. agents — antiweld compounds—which prevent welding of the sliding metal parts.

Extreme-Pressure Agents. Evidence that chlorine and sulfur compounds act as E.P. agents by losing some of their chlorine or sulfur and forming chloride and sulfide films, respectively, was found in experiments by Baxter and collaborators in 1939[4] and by Davey in 1945.[28] These investigators precoated test specimens of different types of testing apparatus with either iron chloride or iron sulfide by exposure to hydrochloric acid or sulfur. When these specimens were tested under high load with uncompounded mineral oil, its load-carrying capacity was found to be similar to that obtained with oils containing sulfur or chlorine when untreated specimens were used.

Simard, Russell, and Nelson[77] found that, by adding lead naphthenate to compounds containing free sulfur, lead sulfate would form under mild loading conditions; under heavy load, lead sulfide is the main product. In the absence of lead soap, they assumed the formation of an oxide film. This mechanism was generally accepted before Davey's investigations, as seen from discussions following lectures by Evans and Elliott[35] on E.P. lubricants. At the present time, based on the thorough investigations by Davey as well as by Prutton and collaborators[70], the sulfide-film theory seems to be well established.

"Active" sulfur and chlorine additives were studied by Prutton, Turnbull, and Dlouhy in 1946[70] and 1947.[69] They postulated that, in the case of a mixed additive, the major part of the boundary film formed is iron chloride. They also observed that active chlorine reacts much more slowly with iron than does active sulfur, and concluded that, in the case of a mixed additive, first a film of iron sulfide forms, with which the chlorine reacts to form the iron chloride coating. In this way the sulfur was credited with serving as a catalyst for the formation of iron chloride. The reaction was studied at high temperatures with sulfur-chlorine addition agents on precoated iron powder. The mechanism was expressed by Prutton in the following equations:

$$R_2S_w + Fe \rightarrow FeS + R_2S_{w-1}$$
$$FeS + R_yCl_z \rightarrow FeCl_2 + R_yCl_{z-2} + S$$
$$S + Fe \rightarrow FeS, \text{ or}$$
$$(n-1)S + FeS \rightarrow FeS_n$$

The formation of similar reaction products on gears was also demonstrated by the same authors. According to this mechanism no free HCl is formed during the entire reaction. Confirming the findings, of Prutton, Turnbull, and Dlouhy by using precoated test pieces in the Shell four-ball machine, Davey[29] hinted at a possible free-radical or chain mechanism which precludes free HCl formation at high load. Davey also stated that the decomposition of the additive under test conditions is proportional to the load and, therefore, the thickness of the boundary film is just sufficient to carry the load.

A study of the E.P. effect of bromine, and iodine compounds in comparison to chlorine compounds has subsequently been reported.[30]

These theoretical considerations seem to help in discussing conditions of boundary lubrication without using the terms "oiliness" and "film strength." Oiliness is mostly used in connection with polar-type boundary lubricants and is generally referred to as the property that allows two lubricants and is geenrally referred have different values for the coefficient of friction as derived from the same testing instrument. At the present time this term is considered vague by many authors because of its lack of any physical meaning or dimension[6, 41, 55]; the extent of the confusion on the meaning of this term was discussed by Hersey in 1933.[45] The term "film strength" refers to the property of a boundary film that enables it to stand up without rupturing even under high load. It is significant that the authors who contributed so much in revealing the mechanism of boundary lubrication[6, 7, 29, 70] do not use either of these terms. With its characteristic numerical values for each lubricant in the different testing machines,* the term "load-carrying capacity," is preferable to "film strength," and should supplant it.

Historical Development

Approximately 50 years ago it was recognized by Albert Kingsbury[50, 51] that, when loads are high or the surfaces are irregular, the action of the lubricant is "imperfect" and its function in reducing friction depends on factors other than viscosity. In 1922, Wilson and Barnard[94] recognized the importance of the field that they called "partial lubrication" when others did not feel that such studies would have any practical value. They stated: ". . . the mechanism of lubrication at low speeds is the most important present problem in the entire field of lubrication from both a practical and a theoretical standpoint."

At first on a trial and error basis, there were subsequently developed a

* Many papers, as exemplified by reference 32, deal with the nature of wear.

* In early experiments the Deeley machine was extensively used[33, 96]; other scientific methods are given in numerous places in the literature.[51, 52, 57, 82] The Shell four-ball machine used in many recent scientific experiments, as well as the other standard tests (Almen, Timken, SAE, Falex, Stick Slip) are extensively described in the literature. Reference is made to a summarizing paper by West on this subject.[92]

number of lubricants that withstood high pressures and temperatures. In cutting operations the use of sulfurized oil became quite general, and similar formulations were applied in the lubrication of transmissions and gears, especially of the hypoid type. It is interesting to note that the studies on the theories of friction and boundary lubrication did not directly lead to the development of lubricants complying with the requirements of this specific field. The mechanism of boundary lubrication in the extreme-pressure region was developed in a deductive manner—after lubricants meeting the requirements of boundary lubrication had been developed—by studies of the reactions taking place at the metal surfaces.

Musgrave revealed[63] that it was purely by chance that the automotive hypoid gear was first tested with a lubricant containing some chemically active sulfur and a lead soap. On the basis of the excellent performance of the lubricant in the first experiment, lubricants of this type were later adopted for use, but without the nature of the product being revealed by the manufacturer.

At a meeting of the American Petroleum Institute in 1931, statements were made by Mougey and Almen[60] which are in full conformance with the understanding of the problem as interpreted today. They attributed the superior load-carrying capacity of E.P. lubricants to a separatory film, which is not an oil but is formed directly on the surface of the metal. Free sulfur was stated to be an active ingredient in successful lead-soap lubricants, since it had been found by analysis of lead-soap lubricants that only those that contained free sulfur gave favorable performance. They mentioned that the use of sulfur in cutting operations had drawn their attention to the possible importance of this ingredient in gear lubricants. Sulfurized mineral oil without lead soap was not found satisfactory, but lead soap formed successful E.P. lubricants in connection with other additives, such as castor oil. Further merits of combinations of sulfur with lead soap, as well as combinations of sulfur-chlorine-treated saponifiable bases with straight or sulfurized mineral oil, were discussed by Mougey and Wolf[61] in 1932. In 1933, McKee[56] and collaborators discussed the load-carrying capacities of various E.P. lubricants on four different testing machines, and showed the lack of correlation between such tests.

In 1934, Mougey[59] distinguished between "powerful" and "mild" E.P. lubricants. It soon became evident that the powerful lubricants were the more desirable for general use.[39, 95] The development of effective E.P. lubricants gained impetus around 1935. In 1936, Byers[20] prepared the first patent review on E.P. lubricants. Zwahl[98] reported in 1937 that, of a large number of products tested at General Motors, 182 hypoid lubricants were satisfactory*. Most of these embodied active sulfur and lead soap. It was found, however, if the active ingredients were present in insufficient amounts, they would be dissipated quickly with a consequent loss in load-carrying capacity followed by gear scoring.[39] In 1937, Georgi[39] emphasized the importance of powerful E.P. agents and proved by road tests that gears should not be operated with mild E.P. agents, even after being "run in" with powerful agents. On hypoid gears operated under high load with mild E.P. agents, light scores develop which have a tendency to "heal." Repeated scoring and healing results in extreme wear because of the cumulative effect of numerous scores over a period of time. Baxter, Snow, and Pierce[4] demonstrated by laboratory experiments conducted on pre-coated test specimens that "run in" of parts with powerful E.P. lubricants is well justified. They also emphasized the time element involved in formation of surface films.

E.P. lubricants of seven different types were extensively tested by Prutton and Willey in 1938.[71] Evaluations were made under different sets of conditions, such as: (1) high load, moderate speed, and normal temperature; (2) moderate load, moderate speed, and high temperature; and (3) very high load, low speed, and normal temperature. Larson[64] pointed out the necessity for two different types of hypoid lubricants: one for high rubbing velocity, as in passenger cars; the other for high torque load, as in trucks. The combination of lead and active sulfur meets high-speed, low-pressure requirements. This type is not nearly as efficient for high-load, low-speed requirements, where better results can be obtained with "non-corrosive" hypoid lubes.

Bowden and Leben[12] studied the physical process occurring during the sliding movement of dissimilar metals. They found the "stick-slip" phenomenon, according to which the frictional force is not constant. Metal surfaces first stick together, and then, because of a pulling motion, a sudden break will cause a rapid slip. For similar metals they observed higher friction, a large fluctuation in the frictional force, and a characteristic track after the sliding. In electron-diffraction studies, Brummage[17] found close relationships between the frictional discontinuities observed by Bowden and Leben and the disorientation by heat of paraffin, fatty-acid, and ester films.

Clayton[24] discussed the behavior of various gear lubricants in seizure tests, using the four-ball machine in studies of liquids of various viscosities. The role of moisture in boundary lubrication was studied by Campbell.[21, 22] The relation between the coefficient of friction and localized high temperatures at the points of actual contact was studied by Bowden and Ridler.[14] Buchin[18] more recently found a sudden rise in the coefficient of friction with decreasing temperatures in a region defined by him as the "Critical Temperature" for the lubricant. The variation of the coefficient of friction with temperature in the boundary region was the subject of studies—using mineral oil with a large number of vegetable and animal oils and fats—by Fogg and Hunwicks[36], and also by Frewing.[38] In 1940, van Voorhis[89] brought the patent survey on E.P. additives up-to-date. Miller, Winning, and Kunc[58] included an extensive patent bibliography as part of a publication on additives in 1941.

A systematic study of the best empirical formulations for chemically well-defined E.P. additives was presented by Evans and Elliott[35] in the same year. In 1944, Wright[97] presented at the Annual SAE Meeting a survey of the trends in lubricating-oil additives, giving a list of patent numbers which included those on sulfurized E.P. agents. Keyser [49] presented a progress report on the gear project of the Co-ordinated Research Council in 1945.

Resistance to film rupture and protection against metal fusion were mentioned as important E.P. functions. Difficulties encountered in writing up proper specifications were further discussed. Patents on additives containing sulfur were discussed by Pritzker, in 1945.[67] In 1946[68], an abstract of the CRC-CLR symposium on gear lubricants was published, in which testing procedures received prominence. West[92] summarized the data and literature on testing equipment for E.P. lubricants. More recently developments in gear lubricants were discussed by Bassett.[3] During the past few years, Federal specification VV-L-761 and U. S. Army Specification 2-105-B have been issued to cover universal gear lubricants. According to an account of Musgrave[63], the performance of these lubricants over the past few years has been amazingly good. Axle failure due to lubrication has not occurred when petroleum oils blended with sulfur-chlorine concentrates were used for lubrication.

The present-day status of cutting

* This report did not include any reference to gear structure or to changes in gear design that made the use of powerful E.P. agents a necessity. Reference 42 contains information along this line.

oils* was well covered by Beard[5] in a recent paper presenting in tabulated form comparative results obtained with sulfurized mineral oil, lard oil, and mixtures of the two. Beard showed that two oils having the same total sulfur content do not necessarily possess identical quality as cutting oils. Thus, an oil with a high natural sulfur content but without added sulfur can not be considered a cutting oil at all; blends of straight mineral oil and sulfurized cutting-oil bases have far superior qualities for cutting operations. The satisfactory action of the latter type of oil is ascribed to the extreme-pressure properties of such lubricants. In wire-drawing operations it has been observed that friction is independent of the drawing speed over a fairly wide range (20-600 cm./sec.[83]) As previously discussed, this phenomenon is recognized as a characteristic of boundary lubrication. The variety of metals machined and the divergence of operations employed make the problem of cutting-oil formulation more involved; according to experts in this field, one product may not serve all needs.[46] Beard has stated that the present trend in cutting oils is toward products that are light-colored, transparent, odorless, and either corrosive or non-corrosive.

* Numerous papers have been published on the chemical and metallurgical aspects of cutting oils; selected references are 9, 10, 27, 57, 73, 74, 75, 76, 78, 79, 80, 83 and 84. In 1943, a semi-technical book was published on this subject.[37] Some references on various sulfurization processes including sulfochlorination are given in references 31, 34, 47, 67, 90, and 93.

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Reprints Available

Reprints of the complete survey of "Sulfurized Extreme-Pressure Lubricants and Cutting Oils" by Dr. Helen Sellei will be available following publication of Part 2, Patent Survey, in the next issue. The reprint will include the present article and literature references, the patent survey to be published next month, and a tabulated summary of the patents surveyed. Copies of the reprint, at 50 cents each, should be ordered from the:

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More to Come

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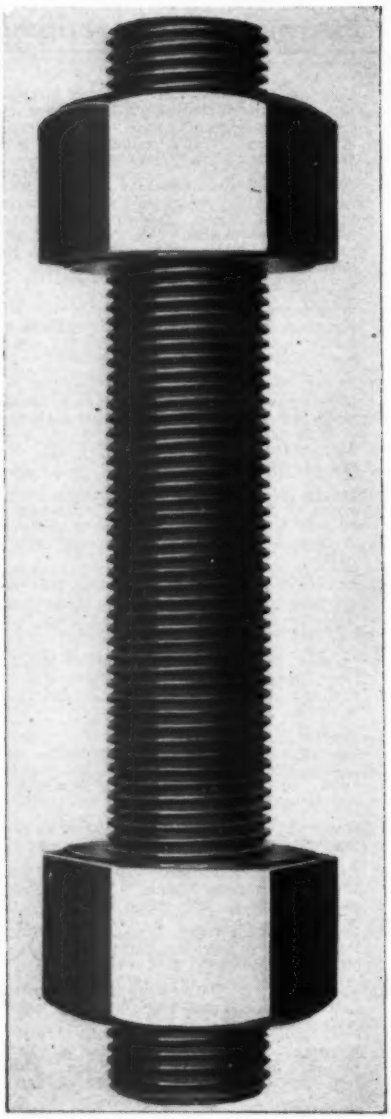

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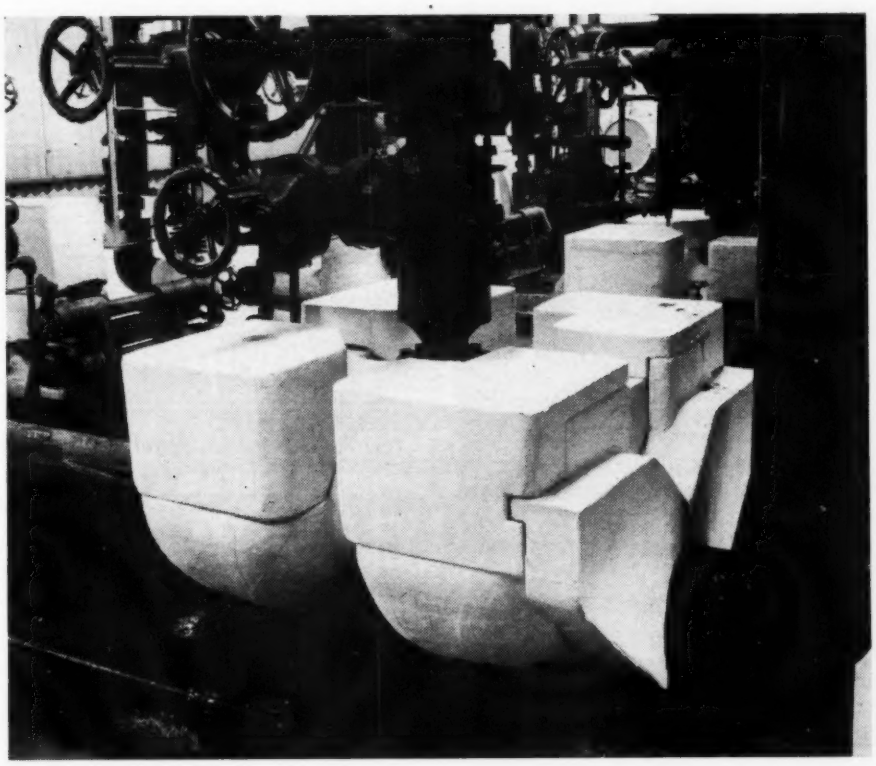
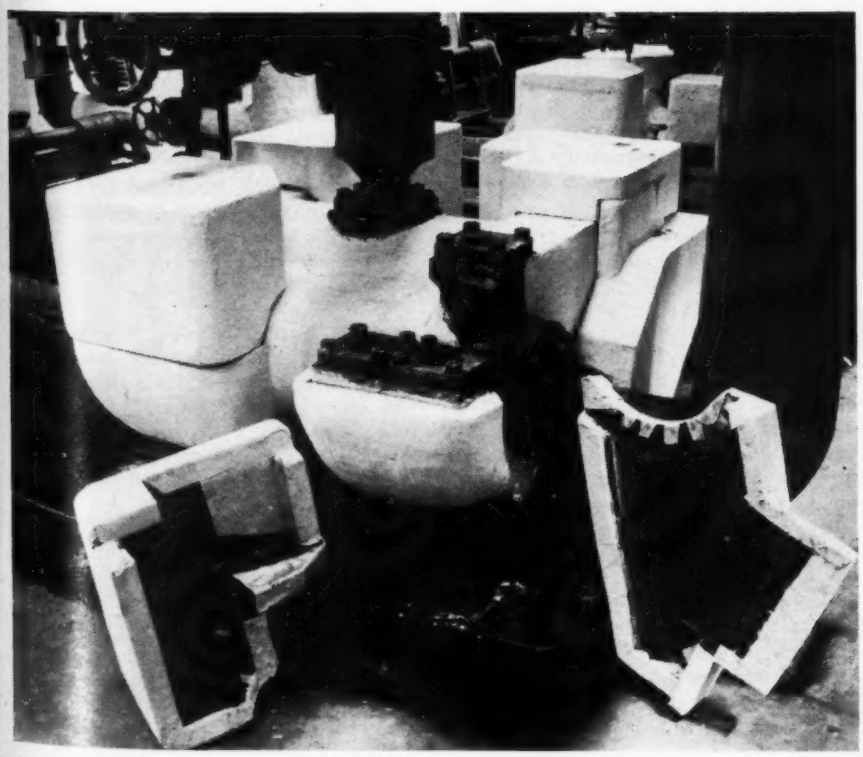
Pump Repairs Are Fast and Easy by Novel Insulation Design

INSULATION is a "must" on hot oil pumps. However, when it comes to maintenance and repairs on hot oil pumps, insulation becomes a headache and a time waster because it has to be torn off to get at the pump parts, and then rebuilt when the job is finished.

Engineers at Socony-Vacuum Oil Co.'s Paulsboro, N. J., refinery decided to do something about this problem and came up with a neat and novel solution by borrowing a bit from the Chinese puzzle idea, as is illustrated in the accompanying photographs.

Using glass foam type insulation blocks cut to the desired sizes—the stuff can be worked easily with a woodsaw, penknife, or what have you—they formed cover pieces shaped to fit over those portions of the hot oil pumps to which access was required, such as heads and valve covers. The blocks are cemented together with the specified adhesive material for that kind of insulation, Benjamin-Foster No. 8133. Asbestos marine paper then is cemented over the outside surface to provide protection for the insulation and to improve the appearance. The paper is painted with an oil and/or chemical resistant paint.





Socony-Vacuum's method of insulating hot oil pumps. Pieces can be taken apart and reassembled quickly whenever maintenance work must be performed on pump parts

The unique feature is in the design of the covering pieces. They are shaped so as to interconnect, holding themselves in place, yet easily lifted out by the maintenance man when necessary.

Although this type of insulation is approximately 20% more expensive than blocks wired on or insulating cements plastered on, the over-all cost is much less, recognizing that the valves and pistons may be removed without destroying the insulation.

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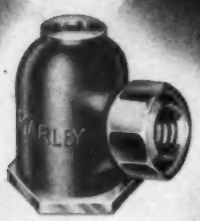

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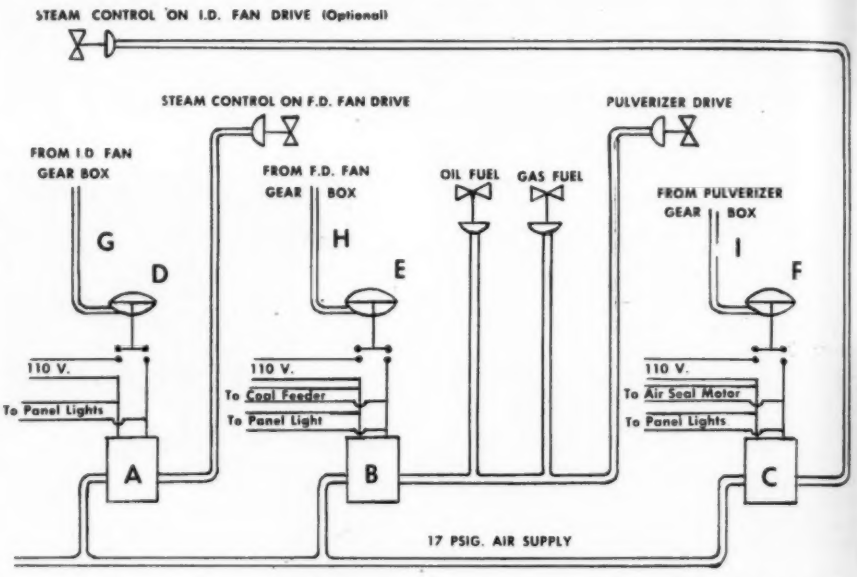

Fig. 1—Schematic layout of instrument arrangement employed by Sohio Petroleum Co. for automatic shutdown of boiler

EMERGENCY shutdown of the combination oil, gas, and coal fired boiler at Sohio Petroleum Co.'s Latonia, Ky., refinery can be accomplished automatically by means of a novel instrument arrangement designed by T. L. Clift, plant instrument engineer.

The instrumentation was designed especially to stop operations in case of trouble from leaking lubricant in the gear boxes of the induced draft fan, the forced draft fan, or the coal pulverizer drive. In addition to shutting down the boiler quickly and safely, it provides a signal on the control panel telling the operator where the trouble started. A schematic diagram is shown in Fig. 1.

The pneumatic section of the system operates at 17 psig., from the plant air supply. During normal operation of the boiler, the Brown electro-pneumatic relays (*A* and *B* in Fig. 1) are closed: and Brown "Pressuretrol" switches *D*, *E* and *F* are open. Normal pressure in the gear boxes and in lines *G*, *H*, and *I* is approximately 12 psig. Switches *D*, *E*, and *F* are adjusted to close when the pressure in lines *G*, *H*, and *I* drops to 7 psig. and below.

In the event of failure or trouble in the induced draft fan drive, the gear box oil pressure will drop. As a result, switch *D* will close, causing relay *A* to open, which sends full 17 psig. air to the diaphragm-motor-operated control valve on the forced draft fan steam, closing it and thus stopping the forced draft fan.

As the forced draft fan slows up, oil pressure in its gear box drops. Switch *E* will close, causing a corresponding opening of relay *B*. This in turn closes the gas and oil fuel valves and the steam valve to the coal pulverizer drive. Finally, as the coal pulverizer slows down, pressure in line *I* drops, closing switch *F*, which operates relays to shut off the pulverizer air seal motor.

An optional, third relay *C* can be used to stop the induced draft fan drive at the same time switch *F* closes. The purpose would be to stop the induced draft fan as soon as possible so as to eliminate the development of even greater trouble at that point. However, it can be argued that it is wise to continue operating the induced draft fan as long as possible to reduce the presence of explosive vapors in the combustion chamber proper.

As indicated in Fig. 1, leads to panel signal lights are taken off just beyond each Pressuretrol switch. As arranged at Latonia, during normal conditions, three green lights glow on the operator's instrument panel. Should trouble develop at the induced draft fan, the boiler will shut down as described above, and three red lights will glow in place of the three green ones.

On the other hand, if the pressure drops at the forced draft fan drive because of trouble at that point, only two red lights will go on; and if the trouble occurs at the coal pulverizer, one red light will show.

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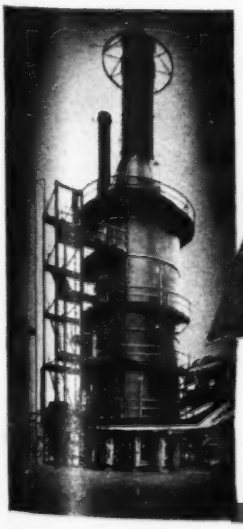

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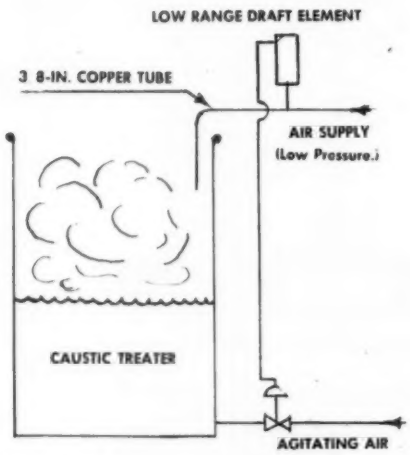


Fig. 2 — Rapid foam rise in caustic treater is detected by Atlantic Refining Co.'s pneumatic control device

A SIMPLE pneumatic control which quickly detects foam rise has solved a messy problem in the operation of caustic treating units for naphtha at the Philadelphia refinery of Atlantic Refining Co. The contents of the treating tanks, agitated by compressed air, were constantly "puking" over the sides because of a rapid build-up of foam.

Use of any mechanical element for control had to be discarded because the foam had insufficient physical body to actuate that type of instrument. The control finally devised is shown schematically in Fig. 2. It consists of a small diameter copper tube—about ⅜ in.—running down into the tank to approximately the level it is desired to keep the foam.

Low pressure air is fed through this tubing as indicated. In use, whenever the foam reaches the end of the tube so as to block the free passage of the low pressure air, the variation in pressure is picked up by a low range draft element. This in turn drives a flapper on an air pilot to transmit conventionally and pneumatically to any convenient control on the agitation air line.

With the supply of agitation air to the caustic treating tank shut down, rapid foaming ceases and the danger of "puking" over the sides is thus under constant control.

IDEAS—Wanted!

Plant engineers, superintendents, foremen!—Send in your own ideas on how "we do it around our refinery." Possible subjects include special gadgets, tools, operating shortcuts, safety ideas, etc. Please include drawings and photographs if available.

Material submitted for publication exclusively in PETROLEUM PROCESSING is paid for at the usual space rates. Send your contributions to:

Plant Practices Editor
PETROLEUM PROCESSING
1213 West Third St.
Cleveland 13, Ohio

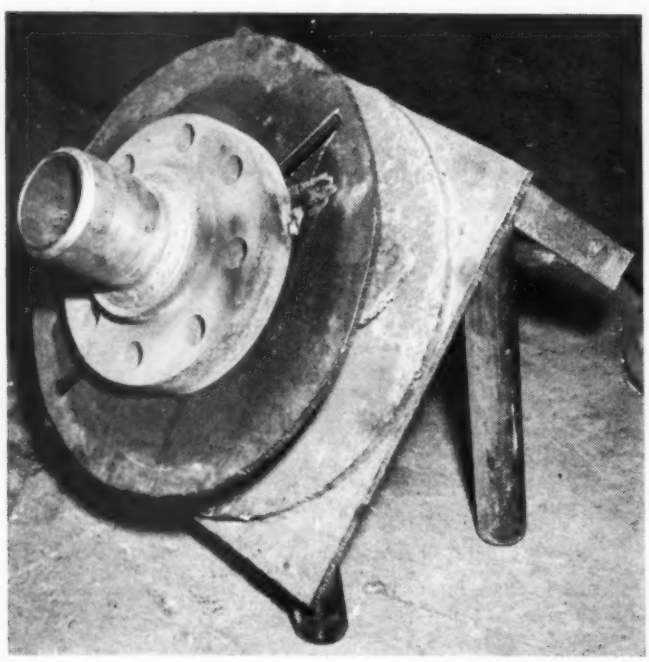
"Tumble-Bug" Turntables Found Useful For Wide Variety of Welding Operations

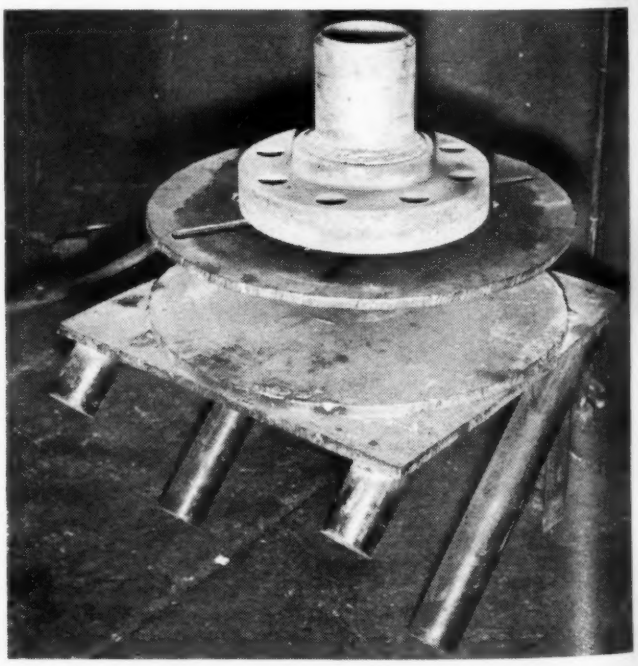
ALTHOUGH welding turntables are gadgets that are rather common to most shops where there is any work at all to be done on round shapes—flanges, short pipe, and the like—maintenance welders at Esso Standard Oil Co.'s Bayway refinery have gone one better.

By putting extra legs on their turntable, and at various angles and of different lengths, they have built a fixture which can be tumbled about and used in any of three different positions, depending upon the job at hand. It can be set up so the bed is horizontal, vertical, or at a 45° angle to the floor. Two of the positions are illustrated in the accompanying photographs.

The turntable proper is composed of an old ball or roller-bearing assembly. One ring is welded to the square base plate; the other is welded to the rotating table.

Photographs show the two positions available with Esso's "tumble-bug" welding turntables





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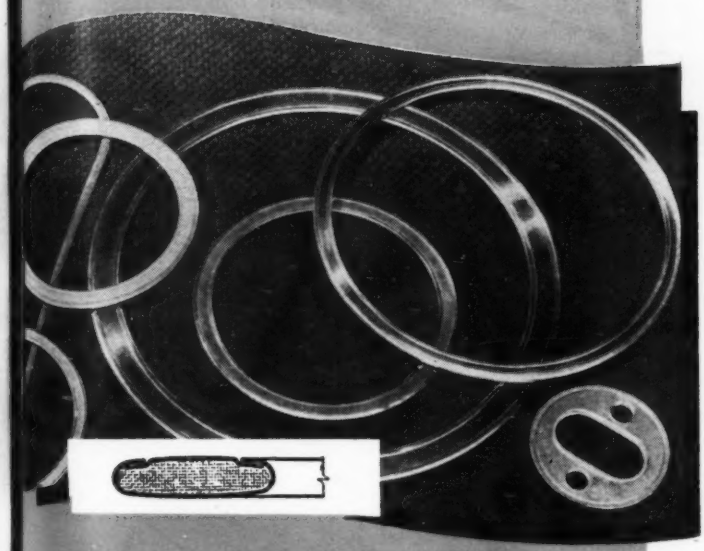

STYLE NO. 923 "Triumph" double-jacketed metal-asbestos for temperatures to 850°F. Standard specifications: Metal, .019" soft steel, .011" or .019" copper, .018" aluminum and .018" Monel; Filler, 1/16" or 3/32" asbestos millboard; Thickness of finished gasket, approximately 1/8".

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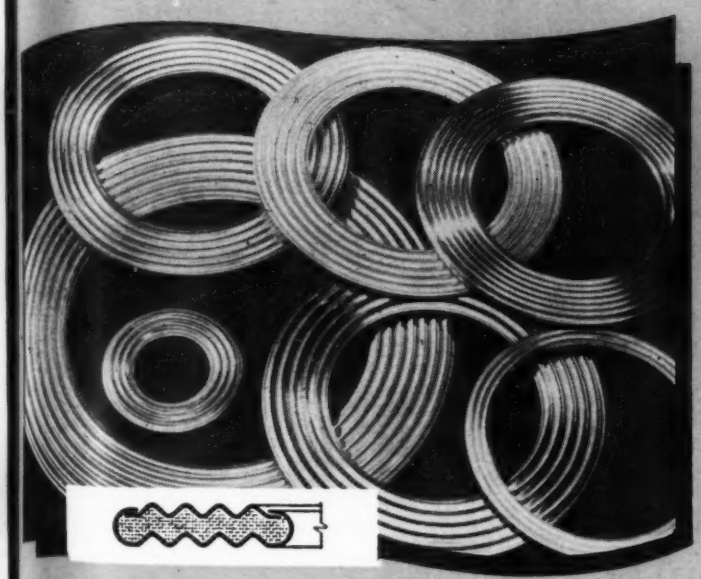
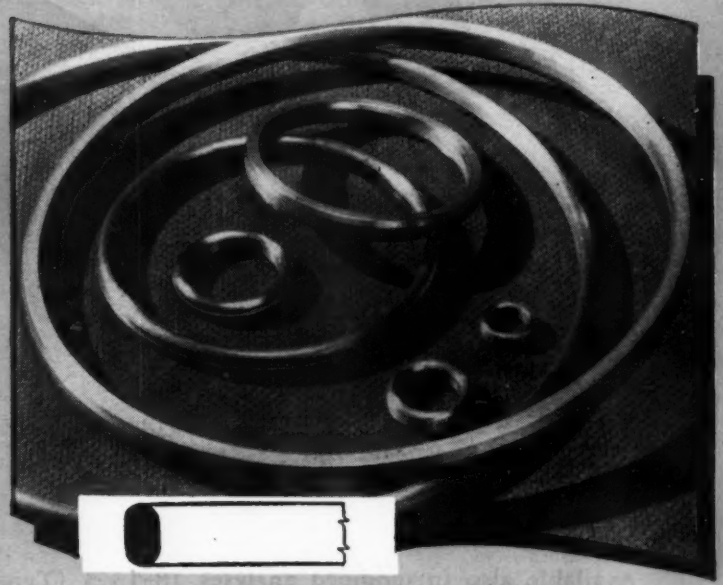


STYLE NO. 926 Corrugated metal-asbestos, combining strength with resilience. Standard specifications: Metal, .019" soft steel, .019" copper, .018" aluminum and .018" Monel; Filler 1/16" or 3/32" asbestos millboard; Thickness, approximately 1/64".



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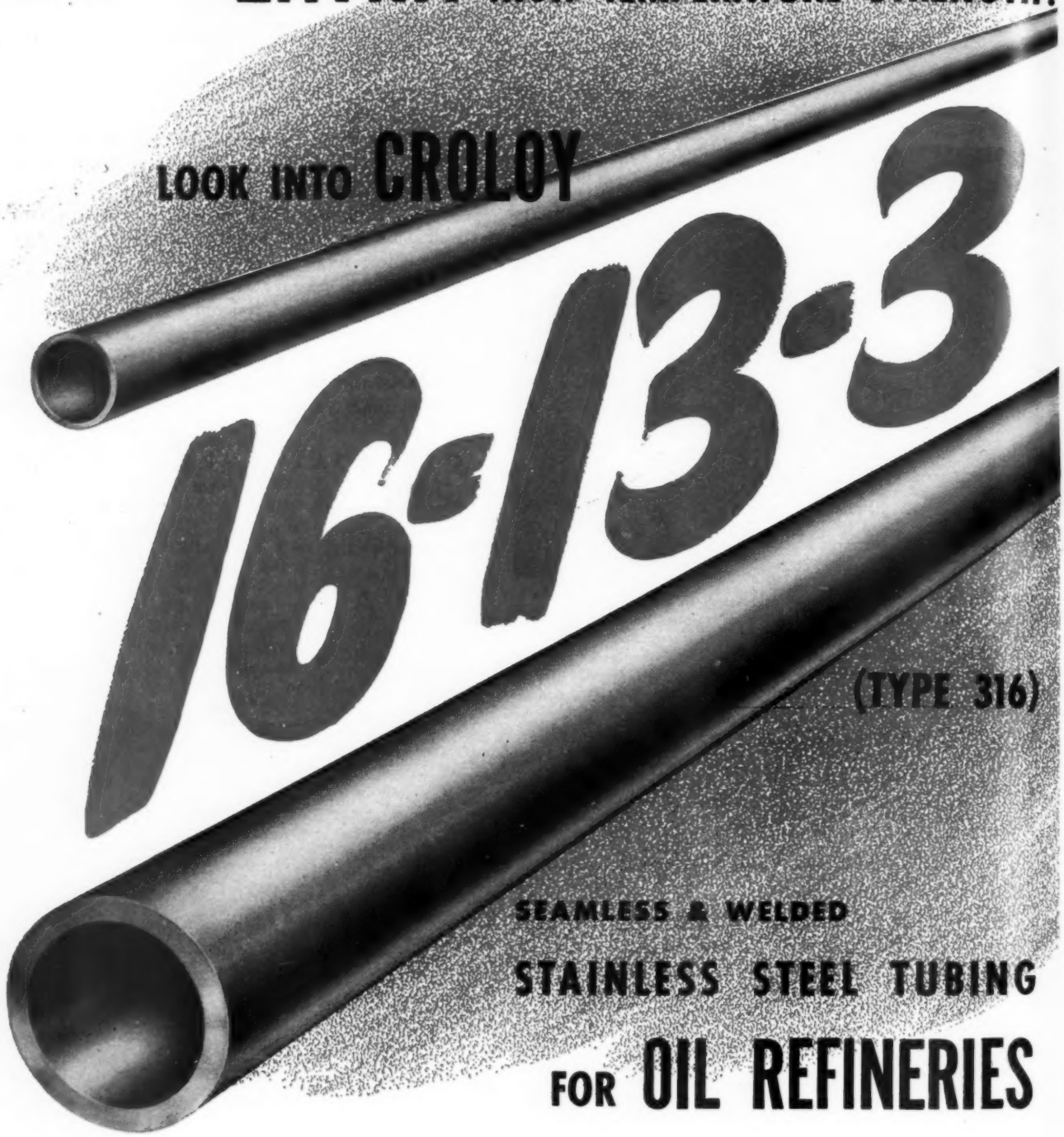

Available also in modified analyses 18–13–3 (Type 317) for extreme corrosion conditions, and 16–13–3cb (Type 316cb) for applications where heat-treatment after welding is impractical. Ask for Bulletin TDC-133 describing physical, mechanical and fabricating properties of these analyses.

TA-1467-S

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Patent Trends in Petroleum Refining

By Peter J. Gaylor, Editor "The Technical Survey"

Solid Polymers from Ethylene

IN the past, oil firms have utilized ethylene, to a certain extent, in polymerization and alkylation, for the production of antiknock gasolines and liquid by-products. However, most of the ethylene, now recovered from refineries, is being consumed in the production of ethylene glycol.

In the years before the last war, work at Imperial Chemical Industries in Britain culminated in the development of a process for making solid polymers (Polythene) from ethylene by high pressure polymerization in presence of oxygen. The manufacture of this product was undertaken in this country by duPont and, later, by one or more other firms and, at the present time, polyethylene plastics are becoming the fastest growing in the field. This is due to the unique properties of the materials with respect to permeability, aging, low or no plasticizer requirement, chemical inertness, toughness, etc.

It is therefore interesting to note that Standard Oil Co. of Indiana is beginning to enter the field through issuance of several recent patents. In U. S. Patent 2,475,628, a continuous process is described in which an ethylene gas stream, containing injected peroxide catalyst, is subjected to polymerization to produce a normally solid product. Among the catalysts used is a hydrocarbon peroxydicarbonate ester, such as diethyl peroxydicarbonate. This compound decomposes with explosive violence when heated above 35° C, but it may be employed as a catalyst by increasing its thermal stability by the presence of unsaturated organic compounds or their polymers.

Polymerization is effected at 4,000-10,000 psig, with preferred reaction temperatures of 35-65° C. Above 5000 psig, the rate of ethylene polymerization does not appear to increase markedly with pressure, although softening temperatures of the polymers increase, and at 8000 psig, it is possible to produce polyethylenes having softening temperatures above 200° C.

The process can be more clearly understood by reference to Fig. 1 which shows a flowsheet in which ethylene is pumped by compressor 11 from line 10, into purifier 13 for removing oxygen, sulfur and nitrogen impurities. Catalyst is pumped in from line 17 by means of pump 18 and joins the compressed ethylene in line 16, and the mixed stream is fed into high pressure reactor 19 which is heated by coil 22. Liquid reaction products are drawn off the bottom of reactor 19 through jacketed line 23 and into separator 27 from which pressure is released and the liberated ethylene is drawn off and recycled through lines 28 and 31.

In reactor 19 the ethylene is polymerized in the gaseous phase under the influence of a homogeneous catalyst. The polymer formed impinges on the surface of the aqueous solution or dispersion of a surface active substance which can be introduced onto the walls of the reactor by a centrally located distributing line 20. A dispersion of the polymer leaves the reactor by line 23.

The polymer dispersion is drawn off the bottom of separator 27 through line 35, cooled, and passed through thickener 37, from which aqueous liquid is drawn out of line 41 at the bottom, while the polymer granules are run into flotator 54 in which web belt 55 picks up the polymer particles and discharges them over comminuting rolls 56 and into drier 61, with dry polyethylene powder being removed through hopper 65.

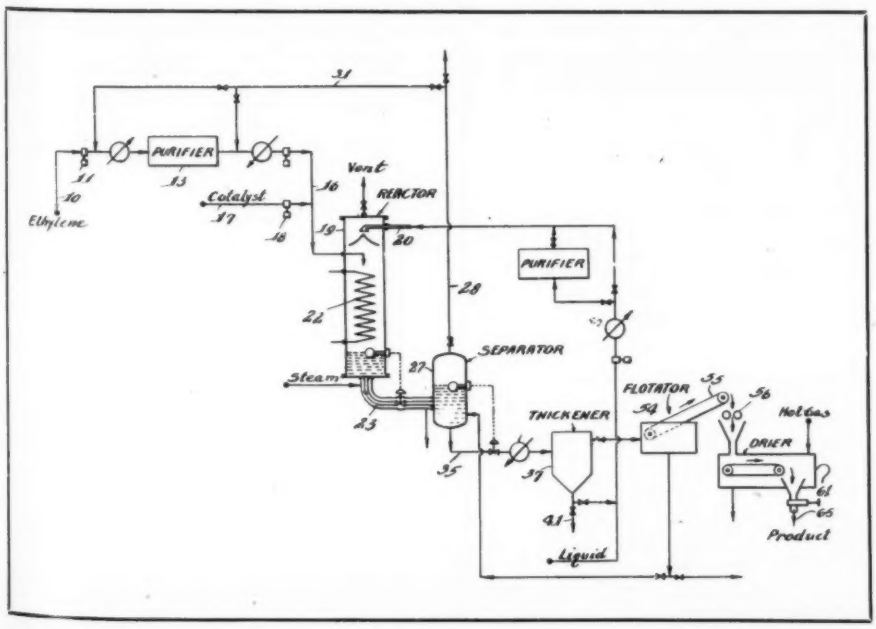

Fig. 1—Flowsheet of solid polyethylene production by Standard Oil Co. (Indiana) process

Patents Issued During July

The following classified listing gives the patent number, patentee or assignee, and a brief description of all patents believed to be of direct interest to the petroleum processing industries, as contained in the Official Gazette of the U. S. Patent Office for July, Vol. 624, Nos. 1-4. Copies of any patent are sold by the Patent Office at 25c each. Order by patent number direct from: The commissioner of Patents, Washington 25, D. C.

Conversions

2,474,827 (Phillips Petroleum Co.)—Separating hydrocarbons by reacting a mixture having a saturated hydrocarbon with tertiary carbon, with an alkyl halide in presence of halide catalyst.

2,474,868 (Houdry Process Corp.)—Hydrocarbon conversion with steam-treated kaolin catalyst.

2,474,924 (The Texas Co.)—Alkylation method.

2,475,025 (Universal Oil Products Co.) — A method for conducting catalytic reactions, and a reactor for close temperature control.

2,475,358 (Shell Development Co.)—Isomerizing paraffin wax.

2,475,993 (Std. Oil Development Co.)—Butadiene from butylenes.

2,476,143-4 (Sinclair Refining Co.)—Pyrolytic conversion of hydrocarbons with aid of a fluidized catalyst.

2,476,416 (Universal Oil Products Co.) — Isomerization of hydrocarbons with aluminum chloride-iron chloride catalyst.

2,476,729 (Phillips Petroleum Co.)—Catalytic cracking with air.

2,476,750 (Phillips Petroleum Co.)—Paraffin alkylation process yielding a product in the motor fuel boiling range.

2,477,038 (Universal Oil Products Co.)—HF sludge decomposition process.

2,477,042 (Std. Oil Development Co.)—Heat exchange in fluidized hydrocarbon conversion systems.

2,477,281 (Socony-Vacuum Oil Co.) — Cyclic hydrocarbon conversion process.

2,477,502 (Socony-Vacuum Oil Co.)—Conducting gaseous reactions in presence of moving particle form solid.

Catalysts

2,474,888 (Std. Oil Development Co.)—Method of preparing silica-alumina gel.
2,474,910-1 (Std. Oil Development Co.)—Preparation of spherical gel particles.
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2,475,628 & 43 & 48 (Std. Oil Co.—Ind.)—Ethylene polymerization, giving solid polymer.
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2,475,977 (Std. Oil Development Co.)—Naphthalene by hydroforming a petroleum naphtha.
2,476,000 (Std. Oil Development Co.)—Solid hydrocarbon polymer.
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2,476,168 (Socony-Vacuum Oil Co.)—Rubberlike reaction product of polysulfide with chlorinated petroleum wax.
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2,477,318 (Std. Oil Development Co.)—Activating hydrophilic coagulating surface.
2,477,380 (Atlantic Refining Co.)—Tertiary aliphatic alcohols.
2,477,382-3 (Calif. Research Corp.)—Aryl substituted alkanes.
2,477,435 (Robert S. Aries)—Oxidation of ethylene and other olefins to their oxides.

Lubricants

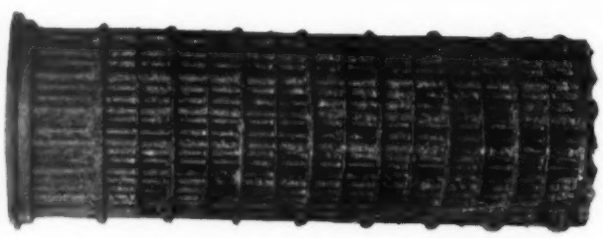
2,474,859 (Rockwell Mfg. Co.)—Ethylene polysulfide polymer as plug valve lubricant.
2,474,881 (Std. Oil Development Co.)—Production of viscous oil by copolymerization of aromatic olefin with mono-olefin.
2,475,246 (Std. Oil Development Co.)—Lubricant containing 0.1 to 10% by weight of oil soluble polymer of formula $CH_2CXCOSR$.
2,475,409-10 (Gulf Oil Corp.)—Corrosion retarding lubricant.
2,475,589 (Shell Development Co.)—Mechanically stable, thermally reversible, non-bleeding, lithium soap grease.
2,475,727 (Gulf Oil Corp.) — Oil containing sperm oil alcohols and Ca, salts of sperm fatty acids, and having improved detergent, antioxidant, and oiliness properties.
2,475,970 (Std. Oil Development Co.)—Lubricant containing pour inhibitor.
2,476,037 (Socony-Vacuum Oil Co.)—Wax substituted diaryl dithiophosphoric acids and salts.
2,476,157 (Socony-Vacuum Oil Co.)—Synthetic lubricants by catalytic treatment of unsaturated ketones.
2,476,271 (Std. Oil Co.—Ohio)—Amine lubricating oil oxidation inhibitor.
2,476,696 (Harvel Corp.)—Hydrocarbon oil inhibited against sludging with hydrocarbon ether of hydrogenated cardanol.
2,476,812-3 (Union Oil Co. of Calif.)—Phosphosulfurized lube oil additive.
2,476,972 (Socony-Vacuum Oil Co.)—Lube oil containing Mg. sulfonate and sulfo-phospho reaction product.
2,477,244 (Std. Oil Co.—Indiana)—Lubricant containing stabilized sulfurized compound.
2,477,296 (Enterprise Oil Co.)—Lithium-aluminum soap grease.
2,477,306 (Std. Oil Development Co.)—Friedel-Crafts condensation product.
2,477,311 (Std. Oil Development Co.)—Grease containing acetylene black.
2,477,356 (Sinclair Refining Co.)—Corrosion inhibited turbine oil.

Hydrocarbon Synthesis

2,474,845 (Hydrocarbon Research)—Hydrogenation of carbon monoxide with fluidized catalyst.
2,475,214 (Std. Oil Development Co.)—Hydrocarbon synthesis with powdered catalyst.
2,476,788 (Std. Oil Development Co.)—Recovery of hydrocarbon synthesis products.
2,476,920 (Std. Oil Development Co.)—Catalyst for reduction of oxides of carbon with hydrogen.

Specialties

2,475,699 (Hartford National Bank & Trust Co., Trustee)—Improving bitumen by blending with polyethylene.
2,476,411 (Atlantic Refining Co.) — Improving adhesivity of bitumen with nitrogen base salt of oil soluble sulfonic acid.
2,477,220 (Union Oil Co. of Calif.)—Anti-knock motor fuel additive.
2,477,538 (Socony-Vacuum Oil Co.)—Polymeric oil from cracked stocks.



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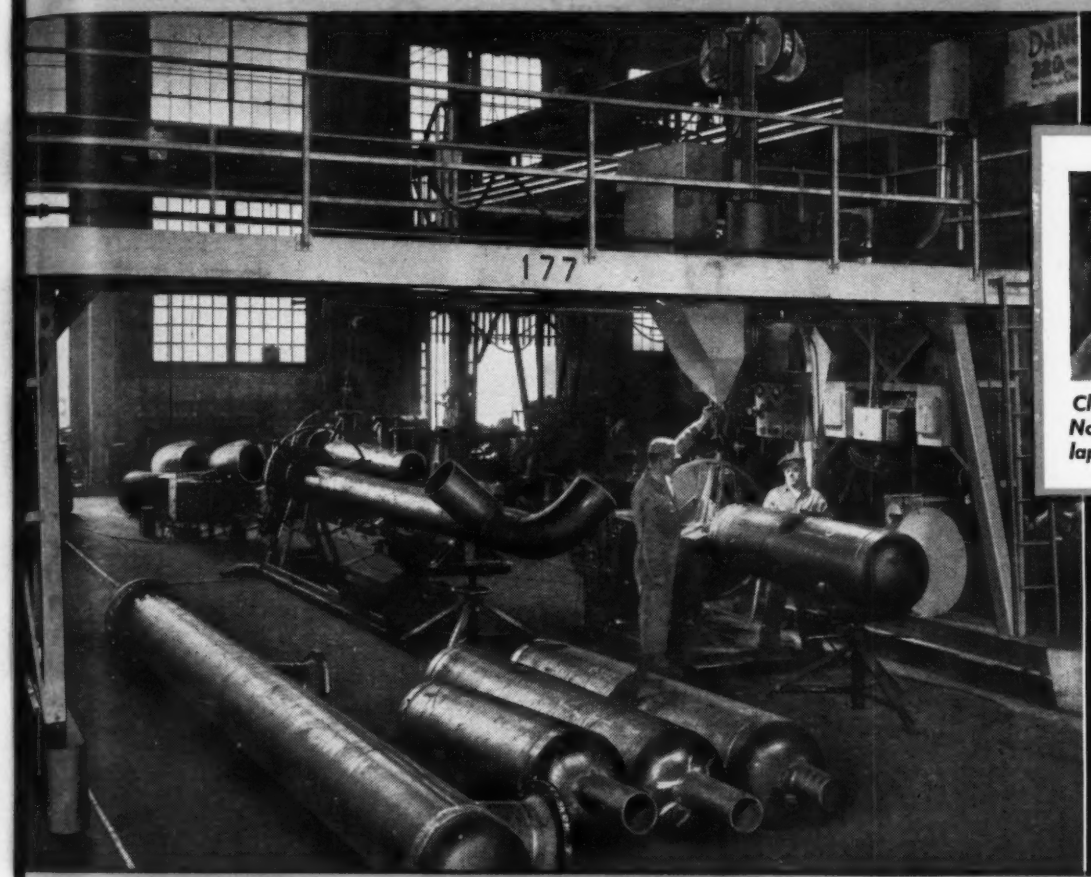
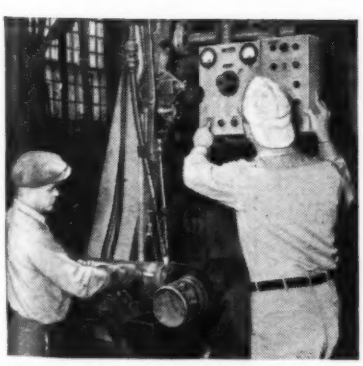


Closeup of the weld being laid. Note smoothness of the overlapping beads.

Movable bridge transports welding head and equipment over the various work rotating machines. Operator is shown adjusting flow of flux that submerges the arc; helper cleans weld with chipping hammer as it rotates past him.

by MIDWEST MACHINE WELDING

WITH SUBMERGED ARC



Operator stops machine at completion of weld by simply pressing button. Push button controls position welding head exactly over work clamped in rotating machine.

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Lubricants

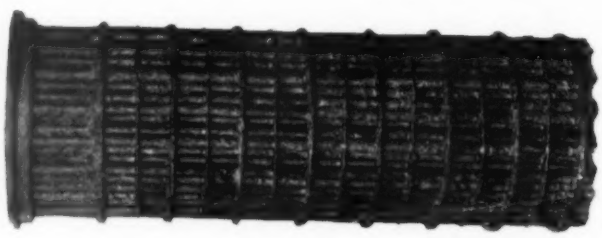
2,474,859 (Rockwell Mfg. Co.)—Ethylene polysulfide polymer as plug valve lubricant.
2,474,881 (Std. Oil Development Co.)—Production of viscous oil by copolymerization of aromatic olefin with mono-olefin.
2,475,246 (Std. Oil Development Co.)—Lubricant containing 0.1 to 10% by weight of oil soluble polymer of formula $CH_2CXCOSR$.
2,475,409-10 (Gulf Oil Corp.)—Corrosion retarding lubricant.
2,475,589 (Shell Development Co.)—Mechanically stable, thermally reversible, non-bleeding, lithium soap grease.
2,475,727 (Gulf Oil Corp.) — Oil containing sperm oil alcohols and Ca, salts of sperm fatty acids, and having improved detergent, antioxidant, and oiliness properties.
2,475,970 (Std. Oil Development Co.)—Lubricant containing pour inhibitor.
2,476,037 (Socony-Vacuum Oil Co.)—Wax substituted diaryl dithiophosphoric acids and salts.
2,476,157 (Socony-Vacuum Oil Co.)—Synthetic lubricants by catalytic treatment of unsaturated ketones.
2,476,271 (Std. Oil Co.—Ohio)—Amine lubricating oil oxidation inhibitor.
2,476,696 (Harvel Corp.)—Hydrocarbon oil inhibited against sludging with hydrocarbon ether of hydrogenated cardanol.
2,476,812-3 (Union Oil Co. of Calif.)—Phosphosulfurized lube oil additive.
2,476,972 (Socony-Vacuum Oil Co.)—Lube oil containing Mg. sulfonate and sulfo-phospho reaction product.
2,477,244 (Std. Oil Co.—Indiana)—Lubricant containing stabilized sulfurized compound.
2,477,296 (Enterprise Oil Co.)—Lithium-aluminum soap grease.
2,477,306 (Std. Oil Development Co.)—Friedel-Crafts condensation product.
2,477,311 (Std. Oil Development Co.)—Grease containing acetylene black.
2,477,356 (Sinclair Refining Co.)—Corrosion inhibited turbine oil.

Hydrocarbon Synthesis

2,474,845 (Hydrocarbon Research)—Hydrogenation of carbon monoxide with fluidized catalyst.
2,475,214 (Std. Oil Development Co.)—Hydrocarbon synthesis with powdered catalyst.
2,476,788 (Std. Oil Development Co.)—Recovery of hydrocarbon synthesis products.
2,476,920 (Std. Oil Development Co.)—Catalyst for reduction of oxides of carbon with hydrogen.

Specialties

2,475,699 (Hartford National Bank & Trust Co., Trustee)—Improving bitumen by blending with polyethylene.
2,476,411 (Atlantic Refining Co.) — Improving adhesivity of bitumen with nitrogen base salt of oil soluble sulfonic acid.
2,477,220 (Union Oil Co. of Calif.)—Anti-knock motor fuel additive.
2,477,538 (Socony-Vacuum Oil Co.)—Polymeric oil from cracked stocks.



Clogged Heat Exchangers

...are expensive to operate

When heat exchangers get clogged with carbonized oil, lime scale, rust and other deposits, they become expensive items to operate. That's why it is a wise plan to give your exchanger units a periodic clean-out.

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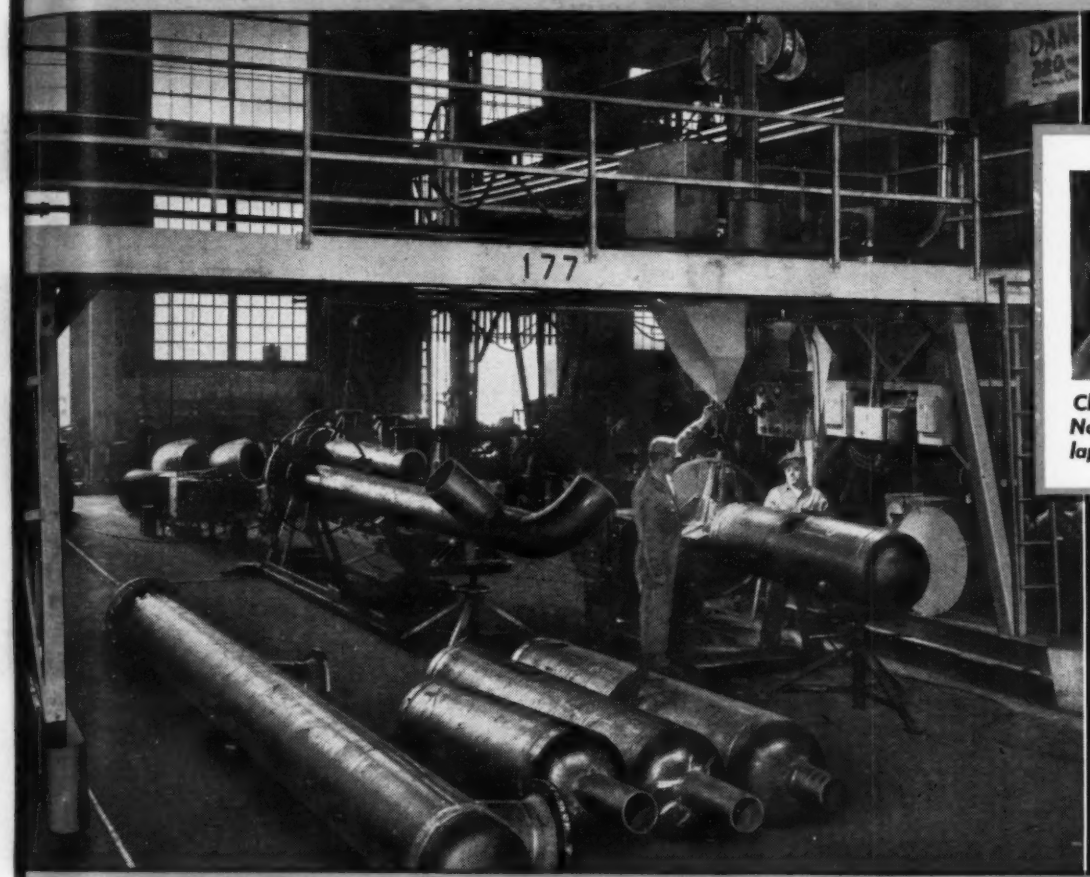
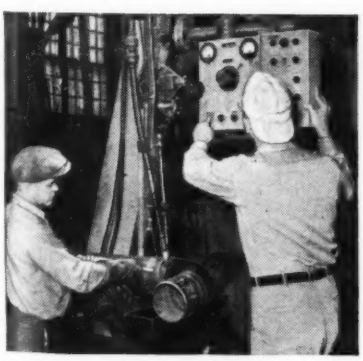


Closeup of the weld being laid. Note smoothness of the overlapping beads.

Movable bridge transports welding head and equipment over the various work rotating machines. Operator is shown adjusting flow of flux that submerges the arc; helper cleans weld with chipping hammer as it rotates past him.

by MIDWEST MACHINE WELDING

WITH SUBMERGED ARC



Operator stops machine at completion of weld by simply pressing button. Push button controls position welding head exactly over work clamped in rotating machine.

Better welding is assured by this Midwest development because the "human element" has been eliminated for all practical purposes. Aside from work positioning, the operator simply starts and stops the machine; his helper chips off the slag . . . all else is automatic.

Quality of the weld is improved because the machine follows the predetermined procedure *exactly . . . everytime*. The puddle is larger and the arc is better shielded and controlled. The possibility of locking up slag is minimized while undercutting is practically impossible. The greater number of beads is a further improvement.

This application equipment, developed and built by Midwest for use in its own fabricating plants, is representative of the modern facilities used by Midwest to assure better piping.

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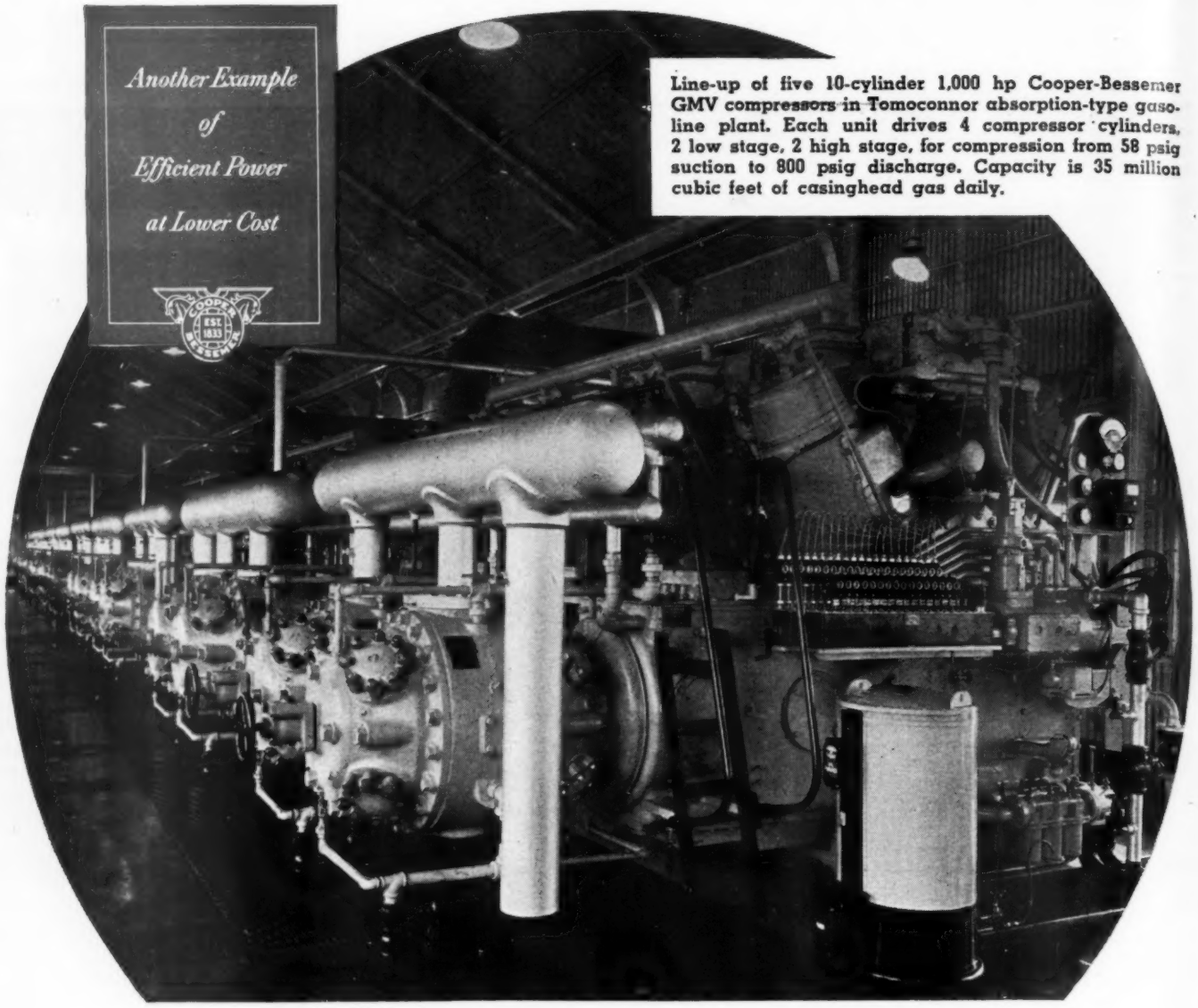
PIPING FABRICATORS AND CONTRACTORS

4 PLANTS ARE BETTER THAN 1

347

Another Example of Efficient Power at Lower Cost



Line-up of five 10-cylinder 1,000 hp Cooper-Bessemer GMV compressors in Tomoconnor absorption-type gasoline plant. Each unit drives 4 compressor cylinders, 2 low stage, 2 high stage, for compression from 58 psig suction to 800 psig discharge. Capacity is 35 million cubic feet of casinghead gas daily.

Line-up of GMVs at Tomoconnor helps line up profits in gas conservation

The Tomoconnor gasoline plant on the Texas Gulf coast is known for its high recovery of hydrocarbons and for unusual economy and efficiency of operation.

Naturally, compressor performance is a mighty important cog in the efficient, low-cost operation of this or any gasoline plant. Here, five 1,000 hp Cooper-Bessemer GMVs, as always, bring a number of significant advantages . . . exceptional compactness for cost savings in housing and installation, month after month of trouble-free, on-stream service, and the kind of over-all operating and maintenance economy that does your heart good.

We could go on and on about the features and advantages that are paying off in GMV-equipped plants. Maybe you have compressor needs coming up. If so, get *all* the facts . . . on GMVs or on our other modern V-angle type compressors . . . 200 to 2,400 bhp.

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Evaporation Rate Is Controlled By Liquid Level Mechanism

In addition to the improved control device for evaporation towers described below, this month's review of new and improved devices used in petroleum processing and handling oprations on which patents have been issued recently includes:

- **An excess-flow valve design based on pressure differential**
- **"Baskets" on distributing tubes give uniform catalyst flow**

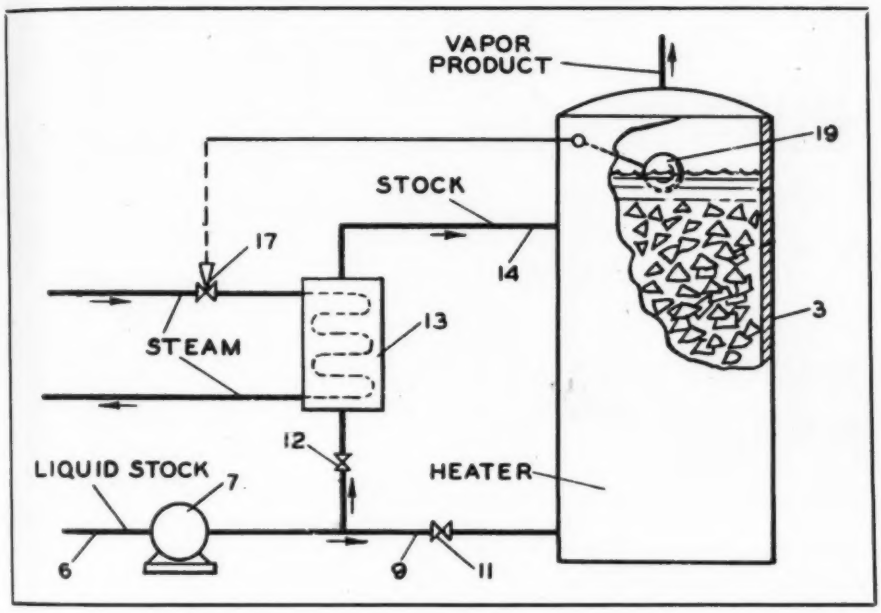

Fig. 1—Evaporation chamber uses float 19 to control auxiliary heat input in coil 13 (U. S. 2,473,737)

SPLIT-STREAM FEED with close control of the amount of heat added to one of the streams has been developed as an improved method of operating a packed evaporation tower or column.

Previously, it is stated, control of fluid level in the tower as a method for regulating the evaporation rate was made by controlling the temperature of the incoming liquid feed in a single stream. There is such a large lag between the time the heated fluid stock enters the bottom of the tower until its addition is effective at the top of the tower that this method causes the fluid level to vary considerably. As a result the amount and quality of vapor leaving the tower may also vary considerably, causing the operation of the fractionator to which it is sent to be difficult to control.

One form of the invention is shown in Fig. 1. Liquid stock to be evaporated enters through line 6, pump 7, and then is split into two streams. The main feed stream goes into the heated chamber 3 through line 9 and control valve 11. The other passes through valve 12, steam coil 13, and line 14 to the upper section of chamber 3.

If the quantity of stock entering at the bottom is more than the internal heater will evaporate, float 19 will rise and cause valve 17 to open, using any suitable valve-actuating transmission means. This permits steam to heat the stream going in through line 14. Then, the increased evaporation rate due to higher heat input brings the liquid level in the chamber down, float 19 drops and valve 17 closes again. In general, it is claimed that there is no "hunting" action on the part of the float control system.

U. S. 2,473,737, issued June 21 1949, to Joseph E. Storment, assignor to Phillips Petroleum Co., Bartlesville, Okla.

Universal Excess-flow Valve Based on Differential Pressure

DIFFERENTIAL PRESSURE is the basis of design of an excess-flow valve which will operate for either forward or reverse flows, can be adjusted for any desired flow rate, and is adapted for high or low pressure service.

Its operation is explained in the drawing in Fig. 2. Orifice plate 2, with an orifice 3 made as large as possible so as to avoid restricting normal flow through the conduit 1, provides a slight pressure differential whenever unwanted, excess flow occurs. This presure is effective immediately on the manometer arrangement comprising vertical chambers 18 and 19 with connecting pipe 21, which unit contains hydraulic fluid 20, preferably immiscible with the fluid passing through conduit 1.

When excess flow conditions are reached, the differential pressure forces float 25 or 26 up (depending upon flow direction) until valve ball 27 or 28 drops into seat 29 or 30, the positions indicated by the broken lines. At that point flow is completely shut off.

The unit is said to be applicable particularly to lines carrying gaseous fluids such as natural gas, hy-

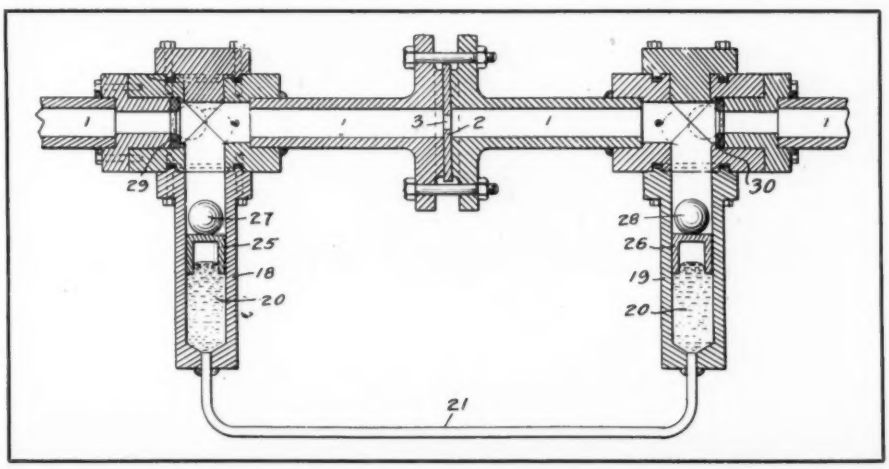

Fig. 2—Differential pressure type excess-flow valve using orifice plate 2 operates in either direction (U. S. 2,475,585)

drogen, nitrogen, etc., but it also may serve on water, petroleum, brine lines or the like. Adjustment for various flow rates is obtained by changing the size of orifice 3 and/or the type of hydraulic fluid 20.

U. S. 2,475,585, issued July 12, 1949, to Carl E. Baird, Otis, Kans.

Baskets on Distributing Tubes Effect Uniform Catalyst Flow

BASKET-LIKE CUPS, or boots, installed at the lower end of catalyst distributing tubes between each heat zone in the regenerator of a moving bed catalytic cracking unit have been designed for the purpose of effecting more uniform flow of the catalyst.

The sketches in Fig. 3 illustrate the baskets. In operation, catalyst passes down through both the orifice 53 and over the serrations 52 part of the time, while at other times flow is through the orifice only. The serrations effectively eliminate the cascading or avalanching occurring where flow of a granular solid is directed over a straight edge.

In general, the dimensions of the basket and its positioning or spacing depend chiefly upon tube diameters. For example: if tube 45 nas a diameter of 6 in.; the diameter of the basket is 12 in., of the orifice is 5 in., and the height of the serrated wall is 7½ in. Other specifications found preferable also are given.

U. S. 2,474,834, issued July 5 1949, to Frank J. Fontana, assignor by mesne assignments, to Houdry Process Corp.

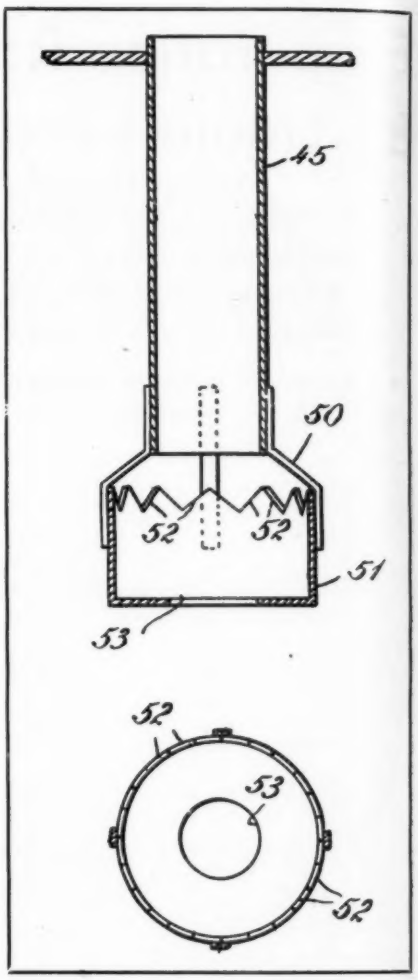

Fig. 3—Vertical and horizontal section through distributing tube 45 and its basket 51 (U. S. 2,474,834)

Other Recent Patents

Space does not permit the complete review of all patents issued recently on equipment for the petroleum processing industry. Following, however, are brief abstracts of those with the greatest interest.

Catalytic Reactor of Fixed Bed type in which there is a series of stationary beds positioned each above the other in a vertical tower, with provisions for periodic regeneration cycles. U. S. 2,475,855, issued July 12, 1949, to Harry F. Peters, and

TWO WAYS OF BURNING OIL

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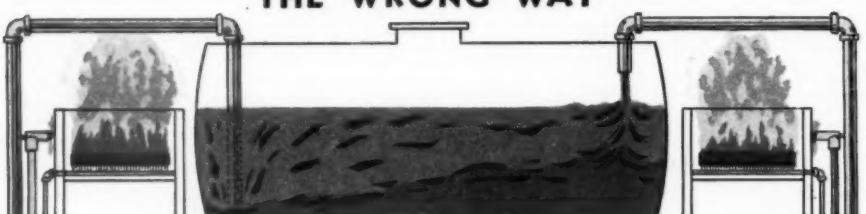
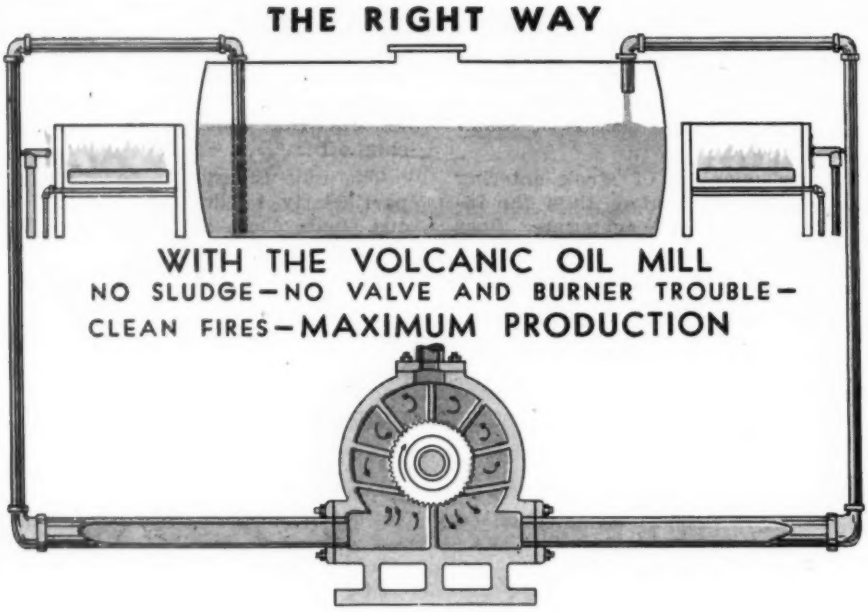


SLUDGE IN STORAGE—VALVE AND BURNER TROUBLES—
UNBURNED OIL—LOST PRODUCTION

THE RIGHT WAY



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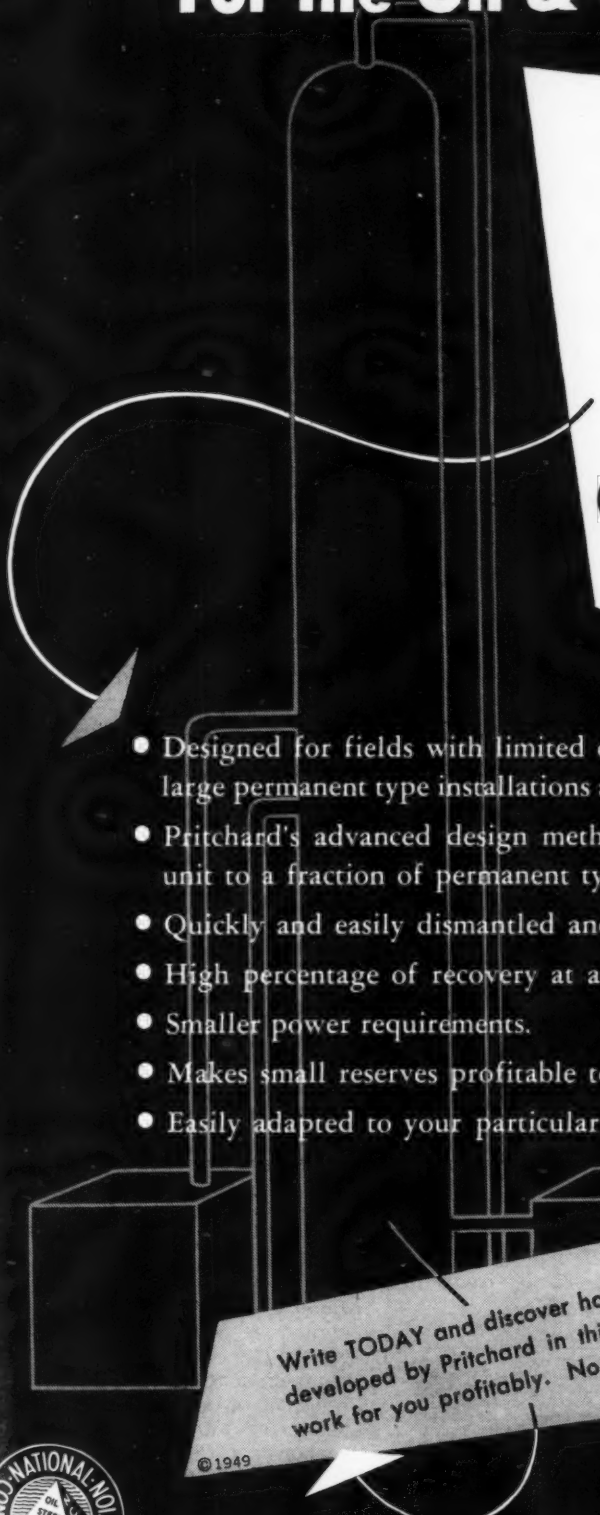

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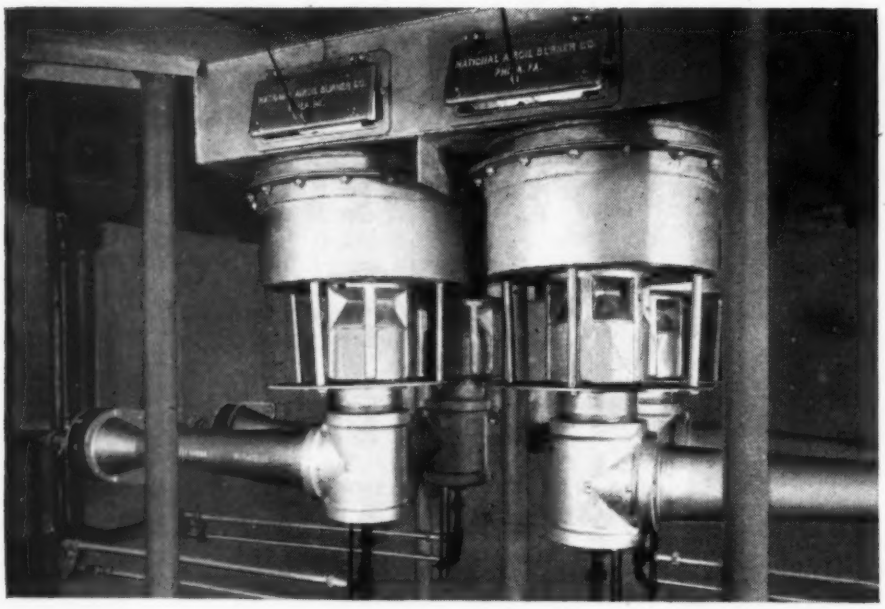

"AIROCOOL" OIL-GAS TANDEM COMBUSTION UNITS

NATIONAL AIROIL FUEL OIL · GAS BURNERS

The above photo shows a group of four NATIONAL AIROIL TANDEM COMBUSTION UNITS, recently installed in a large Pennsylvania refinery. The burners are located at the Petro-Chem Furnace of the Vacuum Distillation Unit in this refinery. Although the installation was one of special application, "National Airoil" TANDEM UNITS very readily "fitted into the picture" with no trouble and a minimum of cost. This is because "AIROCOOL" TANDEM COMBUSTION UNITS are also designed for firing vertically upward, as shown, and are easily applied to all types of process furnaces.

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INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

Equipment Patent Review

U. S. 2,475,822, issued July 12, 1949, to Leland W. T. Cummings, both assignors to Sun Oil Co., Philadelphia, Penna.

Boiler Tube Test Plug, made of heavy duty rubber and so constructed that it is gripped increasingly tighter to tube wall as pressure inside the tube under test is raised. U. S. 2,475,748, issued July 12, 1949, to Gene Leroy, South Charleston, West Va.

Vapor Pressure Indicator for ammonia refrigeration systems using a bulb filled with liquid and vaporous ammonia as a temperature and phase responsive element. U. S. 2,475,218, issued July 5, 1949, to Donald L. Campbell, assignor to Standard Oil Development Co.

Heat Exchanger Support of the so-called floating type, utilizing compression springs and designed for relatively short length exchangers which are under high temperature differentials and consequently suffer high expansion and contraction. U. S. 2,475,109, issued July 5, 1949, to James B. Pendleton, assignor to Phillips Petroleum Co., Bartlesville, Okla.

Separator for Sour Natural Gases employing aluminum baffles with roughened surfaces which have been surface hardened by anodizing to increase their resistance to corrosive materials being handled. U. S. 2,474,540, issued June 28, 1949, to Earle S. Marsh, assignor to The Fluor Corp., Los Angeles, Calif.

Manometer with Mercury Trap and a filter for the pressure medium, which eliminates the necessity for cleaning the manometer tube; designed for gaging gasoline tank pressures. U. S. 2,475,602, issued July 12, 1949, to Albert C. Forst, Alameda, Calif.

Rotary Pump for high or low speed operation, large or small quantities of fluid, utilizing axially sliding vanes; and of the self-priming type. U. S. 2,475,844, issued July 12, 1949, to Guy Arnold Jones, assignor to Eaton Pump Mfg. Co., Inc.

Lube Oil Filter Material Feeder, designed so as to eliminate the usual difficulties met from the moisture content of the filter material being released as steam vapors while it is being fed into the hot liquid hydrocarbons. U. S. 2,472,459, issued June 7, 1949, to Daniel B. Banks, assignor to Sun Oil Co., Philadelphia, Penna.

Reciprocating Pump Piston for handling abrasive slurries in which wear is reduced considerably by using rubber, or rubber-like composition, materials on the main wearing and rubbing surfaces. U. S. 2,473,064, issued June 14, 1949, to Arthur L. Leman, Houston, Texas.

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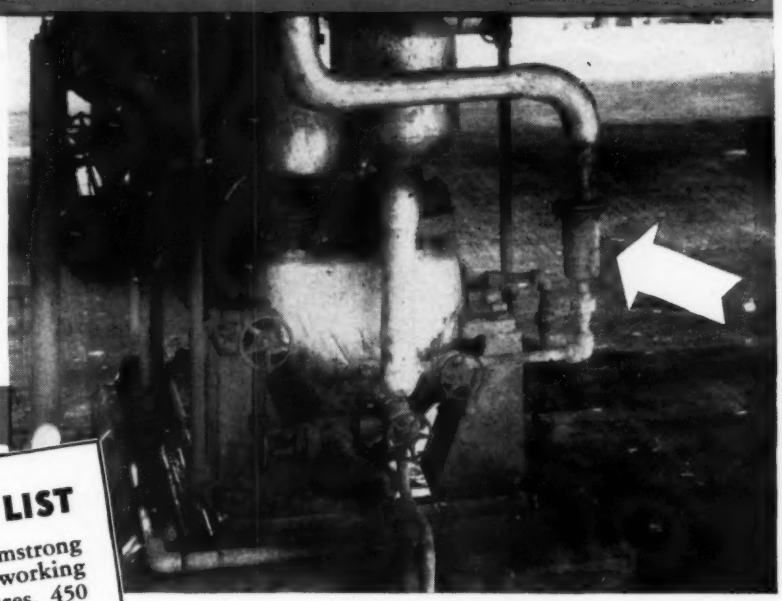

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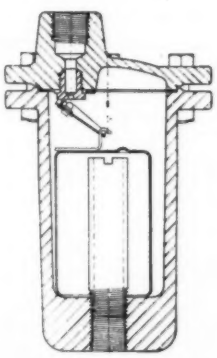

Cross-section of an Armstrong No. 3211 forged steel trap. Forged cap and body. Compressed graphited asbestos gasket. All stainless mechanism. This trap will take high temperatures and abuse without danger of fracture.

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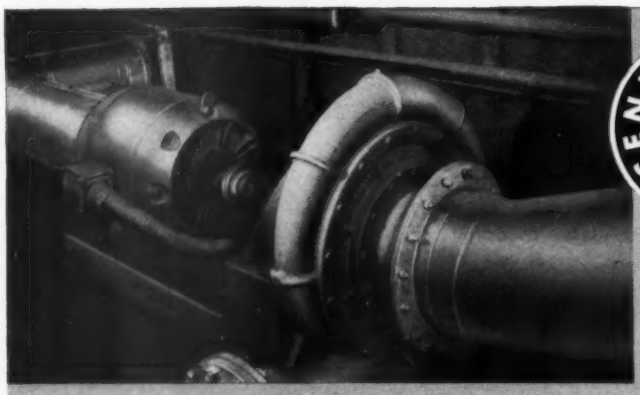
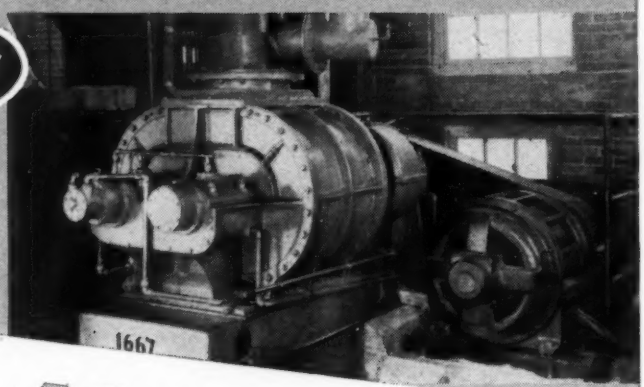


R-C Centrifugal Blower, type OIB, in foundry service. Capacity 6,000 CFM, at 21 oz. pressure.

ROTARY



R-C Rotary Blower, type RCD, capacity 6,200 CFM.

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Equipment Patent Review

Valve-actuating Mechanism in which hydraulic pistons and cylinders are employed in place of the usual yoke arms, without otherwise changing the original valve design. U. S. 2,473,-013, issued June 14, 1949, to Charles R. Crane, II, and Alfred Mueller, assignors to Crane Co., Chicago.

Drum Handling Fork Lift Truck employing auxiliary equipment in the form of a "hoop" type grab device for gripping and transporting cylindrical containers. U. S. 2,473,410, issued June 14, 1949, to Angelo J. Bevevine, assignor to L. Sonneborn Sons, Inc., Petrolia, Penna.

Mover for Tank Cars, box cars, and the like, in which air-operated pistons are utilized as the prime motive power in place of the conventional lever and ratchet arrangement. U. S. 2,473,109, issued June 14, 1949, to Joseph A. Schneider, Hirsch, Saskatachewan, Canada.

Oil-water Emulsion Treater of improved design in which the oil-water mixture is spread across the treater below the heating chamber and its direct flow is retarded sufficiently to cause entrained water to precipitate, thus reducing the liquid load on the heating chamber. U. S. 2,474,-475, issued June 28, 1949, to Clarence O. Glasgow, assignor to National Tank Co., Tulsa, Okla.

Fluid Catalytic Reactor for highly exothermic and endothermic reactions, providing for close temperature control by the use of added heat exchange medium flowing in indirect contact with the reaction zone. U. S. 2,475,025, issued July 5, 1949, to Lyman C. Huff, assignor to Universal Oil Products Co., Chicago, Ill.

Rotary Contactor for Fluids designed for improved separation of the fluid phases by provision of shielding means at the interface level between the two phases in the contact zone. U. S. 2,474,006, issued June 21, 1949, to Russel L. Maycock, assignor to Shell Development Co., San Francisco, Calif.

Absolute Pressure Meter which does not require the usual compensating links and levers to correct for changes in the surrounding atmospheric conditions. U. S. 2,477,233, issued July 26, 1949, to Carlton W. Bristol, assignor to The Bristol Co., Waterbury, Conn.

How to Obtain Patents

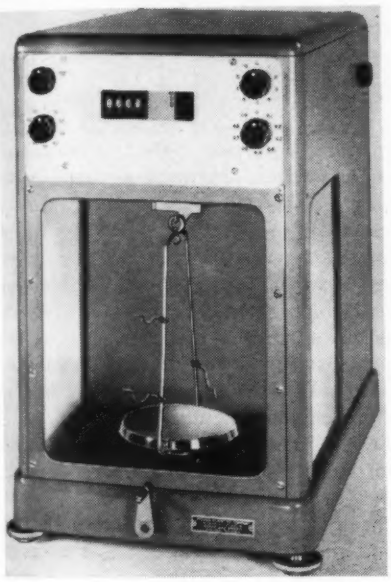
Readers may obtain copies of any U. S. patents from the Patent Office at 25 cents each. Order by patent number direct from: The Commissioner of Patents, Washington 25, D. C.

What's New!

EQUIPMENT . . . MATERIALS . . . PROCESSES . . . LITERATURE

Reviewed by WILLIAM C. UHL, Equipment Editor

1—Rapid Refinery Analyses



Weighing petroleum fraction samples to 1/20 of a milligram with analytic balance accuracy, but in one-third the usual time is made possible by the new direct-reading "Gramatic Balance." The instrument is said to be ideal for refinery control laboratories. It has only one pan, and the weight reads directly on a scale at eye level, eliminating a usual source of error in adding up individual weights. All required weights are built in and manipulated by turning four external knobs. Weights less than 0.1 gm. are indicated optically and automatically. Total weight is read directly from the panel scale. Sample can range from 200 gms. to 0.0001 gm. Tests have shown that inexperienced operators can learn to weigh samples in 20 to 25 secs., after less than one hour's practice, it is claimed. Fisher Scientific Co.

For More Information

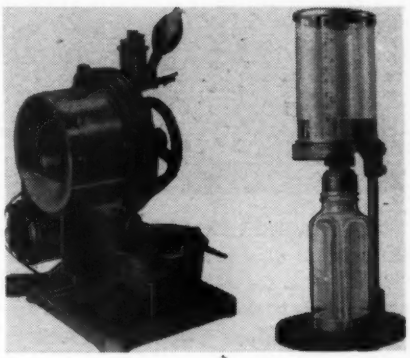
Use one of the attached reply cards to request additional information or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers on the items you're interested in, fill in the rest of the card, and drop it in the mail. **No postage required.**

2—Low-cost Heater Design

Simplified design in a new vertical tubular heater includes a number of features aimed at holding initial and maintenance costs to a minimum. Single tubes are used for both radiant and convection sections, thus permitting placing of any number of tubes in parallel, with no crossover connections. Tubes are bare in the lower, or radiant zone, and are covered by sleeves in the upper, or convection zone, flue gases passing through the annular spaces thus formed. The radiant section walls are completely covered by the heating elements, effecting a low refractory temperature behind the tubes and reducing refractory maintenance. The heaters are suitable for every process duty, and designs are available for heat absorption capacities as low as 1,000,000 Btu./hr. The unit is described in a new brochure, Bulletin No. 0-49-7. Foster Wheeler Corp.

3—Mercury Catalyst Cleaner

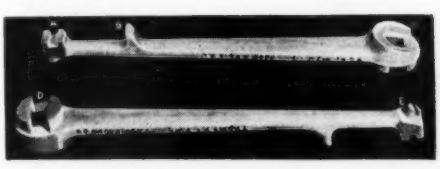
Petroleum refineries using mercury as a catalyst can clean the mercury for re-use with the "Bethlehem Mercury Oxifier," which removes dissolved metal through an oxidation process, followed by removal of oils, dusts, etc. by filtering through the "Type F gold adhesion" filter. The oxifier is essentially a glass drum into which the mercury is poured and whipped into a thick spray by an electrically-driven agitator. The process is founded on the principle that base metals oxidize with air and reduce to a dry, powdery non-cohesive



oxide, which then can be separated from the clean mercury. After agitation, the mercury is poured off and held in a separate receptacle until all oxide particles rise to the surface. Where only physical dusts or oils adhere to the mercury surface, the gold alloy filter serves to remove them. Residual contamination following treatment is said to be less than one part per million. Behtlehem Apparatus Co.

4—Drum Plug Wrench

The "Saf-T-Plug" wrench that will fit any size plug on any type of drum —about 30 different style plugs—has been developed recently. It will service large filler or small drain plugs, compound or double type plugs, and where seal cap rings are used. Of one-piece construction with no moving parts, there are no adjustments to make and the wrench is tapered at an angle of operation to give plenty of hand clearance to avoid skinned knuckles. It weighs three lbs., is heat treated, cadmium plated, and balanced for ease of handling. Price is $5.00 each, postpaid. Wm. C. Richards Co.



More "What's New!" Items, p. 1026

5—Gage Glass Safety Shield

The Frank E. Brown Safety Shield, extruded of transparent, tough "Tenite," affords protection against accidental breakage of column-type, liquid-level, glass gages on vessels or equipment containing light oils, corrosives, and the like. If the glass is broken, the shield safely contains the broken glass fragments, and directs the spray of escaping matter away from the operator. The plastic itself is resistant to impact, shatterproof and chip-proof. The shield has been tested to withstand hydrostatic pressure of 950 psig., at −58° F. Caps of a soft material serve as closures for the short vent tubes, keeping out dust and moisture from the inside. These closures displace themselves under the slightest pressure, thus the shield is not required to withstand additional pressure for the purpose of blowing off the caps. The shield has a wall thickness of ⅛ in., and is 2 in. in diameter. It can be supplied in any length. Frank E. Brown Co.

6—Tightens Four-inch Bolts

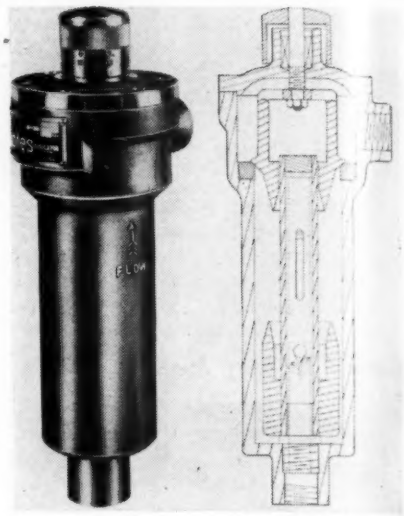
Rated for handling up to 4-in. bolt size, the "Slugger," Size 588, Air Impact Tool is said to furnish considerable time-savings on such jobs on large equipment in oil refineries, chemical plants, power plants, and the like. In one application on tightening nuts, 10-5/8 in. across the flats, by hand atop a large machine required erecting a scaffold on which three men could work with a heavy sledge. Following that, an overhead crane was used to provide the final tug. Time to tighten four nuts was 4½ hrs. A Slugger required no scaffold and the crane only for lifting it into place. Time with only two men was 12 minutes. The tool weighs 215 lbs. and has a free speed of 355 rpm., with 550 impacts/minute. Overall length to shoulder of anvil is 26-5/8 in., side to center distance of the hammer case is 4 in. Standard equipment includes a safety live air handle with independent reverse, suspension ring, and dead handle. Ingersoll-Rand Co.

7—Portable Microfilm Device

The Bolsey Portable Microfilmer, using a conventional 35 mm., miniature camera, makes possible the microfilming of blueprints, drawings, reports, log books, technical data, etc. without sending the original material off the plant premises. In addition, because short lengths of film are used, they may be developed in daylight tanks right on the job where secrecy may be important. Low in cost, the unit is entirely self-contained, with camera, lights, reader, support stand and accessories carried in a case, weighing 18 lbs. The field covered by the Microfilmer is approximately 9 x 14 in., large enough for legal-size documents, patent applications, etc. List price for the unit is $179.50 complete, tax included. Migel Distributing Co., Inc.

8—Flow Regulator

Pre-set flow volume is held constant while upstream pressure may vary over a 100 psig. range in the new Kates Regulator, which employs no pressure pipes, external valve, springs, or levers. Unit is contained in a vertical cylindrical case, with valve seat and disc near its upper end. An opening in the center of the valve disc forms a differential pressure orifice, and a movable disc concentric in this orifice opens and closes a high pressure valve in the lower part of the case. Thus constant differential pressure (and the constant flow causing it) is regulated. This condition also exists across the surrounding valve as well, and causes constant regulated flow through it as well as through the central orifice. Change of the opening of this surrounding valve provides variation of flow in direct proportion to the area of the opening. A threaded valve stem adjustment gives a linear scale in gpm. The device is said to be applicable to fuel lines, and injection, blending, backwash, and rinse control in water treatment installations, and a wide range of chemical plant uses. The W. A. Kates Co.



9—"Push-button" Mercury Still

Automatic electronic controls regulate the induction heating and mercury flow systems in the new Eberbach Mercury Still. Using start and stop buttons, the operator needs only to supply the raw mercury, which begins to flow within 4 to 6 minutes after the start button is pushed. Power consumption of 500 watts produces 5 to 7 lbs./hr. of distilled mercury. Fully automatic safety devices protect the unit, which operates directly from 115 v., 50-60 cycle, AC. It occupies floor space 18 x 24 in. and stands approximately 6 ft. high. Eberbach & Son Co.

More "What's New!" Items, p. 1028

We carry your water conditioning job a step further

The efficiency and economy of any water conditioning installation depends, to a great extent, upon the design of the equipment. But to make certain that the design will be right for *your* requirements . . . we, at Graver, carry the job a step further.

PRELIMINARY ANALYSIS — Your raw water supply is thoroughly investigated and the results form the basis for all future calculations. A sample of your water supply, sent to our laboratories now, will get your job started. There is no obligation.

SURVEYS — The requirements for your conditioned water are thoroughly studied, together with the advantages of the several types of equipment which may accomplish the job. The one type which offers maximum efficiency at minimum cost is recommended.

CERTIFIED FINAL ANALYSIS — Before design work is started we will furnish a certified final analysis of the treated water, the conditions of which must be met or exceeded by the completed installation.

ERECTION—Competent field erection crews are available for the installation of your Graver equipment. These crews are your assurance of a job well done in this final phase of meeting your water conditioning problem.

Call Graver today. Let us start now to carry your job a step further.

GRAVER WATER CONDITIONING CO.

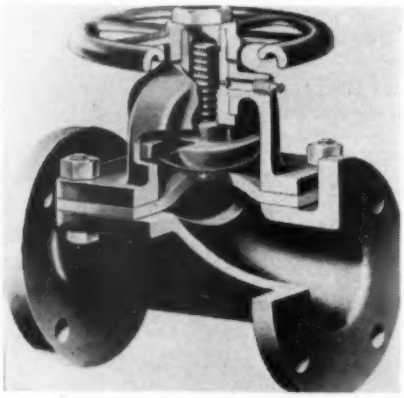
216 WEST 14th ST., NEW YORK 11, N. Y.

CHICAGO • PHILADELPHIA • CLEVELAND

GRAVER

A DIVISION OF GRAVER TANK & MFG. CO., INC. EAST CHICAGO, IND.

10—Sulfuric Acid Valve



Development of a new plastic diaphragm for use in Hills-McCanna Saunders Patent Diaphragm valves has been announced. It is said the new material makes possible the handling of 66° Bé. sulfuric acid without the leakage, dripping, or sticking problems generally encountered in valving this acid. Under present plans, these valves will be furnished in sizes from ½ through 4 in., with a choice of cast iron, cast steel, Durimet, or glass-lined bodies. All but the glass-lined will be available with flanged or screwed ends, the glass-lined in flanged only. All sizes are suitable for pressures up to 100 psi. and temperatures to 125° F. Hills-McCanna Co.

11—Oil Acidity Test Kit

Neutralization number of transformer, turbine, and other mineral oils can be checked reliably and quickly, and without technical skill, by means of a new portable test unit,

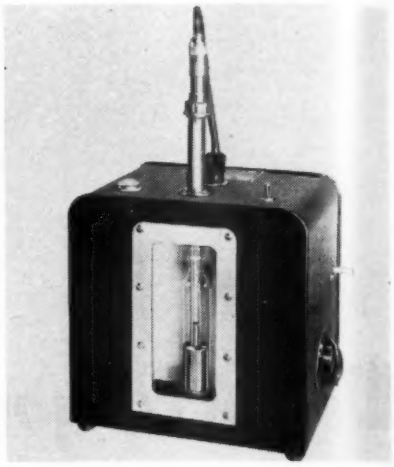
the "Gerin Kit." Potassium hydroxide is furnished in single, measured doses in sealed ampoules, instead of being applied from an open bottle. Ampoules are supplied with neutralization value of 0.3, 0.6, and 1.5 mg. of KOH per gm. of oil. The test is made with 1/3 oz. of oil sample and takes about two minutes to complete. The kit includes four glass cylinders, two pints of neutral water-alcohol-pink indicator solution, 20 ampoules of KOH, and files for opening the ampoules, boxed in a mahogany case. It is priced at $25 fob. Red Bank, N. J. Additional supplies cost 13c per test. The Gerin Corp.

12—Alloy Withstands −423° F

Capable of use in sub-zero service at operating temperatures as low as −423° F., the new Lebanon Grade 22 is an austenitic cast ferrous alloy containing 19.5% chromium and 9% nickel, among other constituents. It has already been used in producing castings for pressure equipment in storage facilities for liquid oxygen used as rocket propellant, such storage being maintained at high pressures and temperatures of about −298° F. Tests show the material undergoes no structural changes under sub-zero conditions. Tensile strength increases to approximately 200,000 psi. at −423° F., with retention of adequate strength factors and resistance to embrittlement. It can be welded either by gas or electric processes without need for subsequent heat treatment. The alloy also has high temperature resistance and is being used in some jet-engine components, turbo-supercharger parts, and other gas turbine uses. Lebanon Steel Foundry.

13—Vacuum Controller

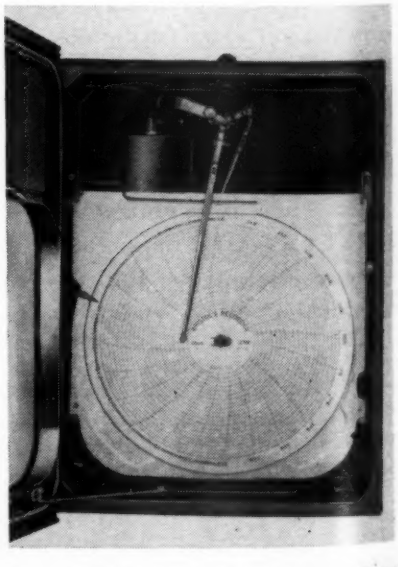
The "Micro-Set Manostat," operating on a principle of controlled leaks to the atmosphere, will regulate and hold a constant vacuum when installed between a vacuum pump and a distillation system in the laboratory. Excess vacuum is leaked constantly, if necessary, through one end of a double glass stopcock. Leakage at the other end of the stopcock is controlled through a platinum-to-mercury regulator which actuates a solenoid (through a relay) to open or close a leak as needed. Control sensitivity is stated to be better than 0.05 mm. Hg. Ground



glass connections are used between all glass parts. The entire unit is enclosed in a dust proof housing. Overall dimensions are: depth, 7½ in.; width, 12 in.; and height, 18 in. Precision Scientific Co.

14—Absolute Pressure Gage

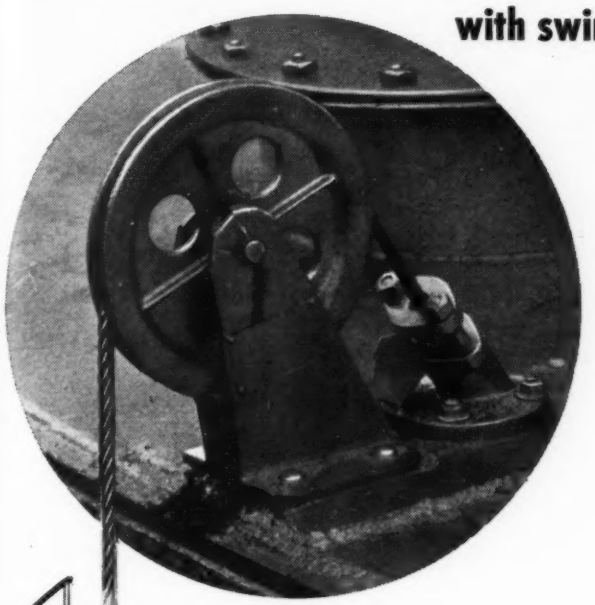
The new Bristol Series 500 Recording Absolute Pressure Gauge is a mechanical type recording instrument based upon a new principle, involving a pressure-sealed lever arm so constructed that it is frictionless, entirely free from lost motion, and free of turning moments due to changes in differential pressure across it. The design is said to make possible the recording of extremely low absolute pressure ranges. Units are offered in ranges from 0 to 20 mm. Hg. and up. Several instruments with a range of 0 to 6 mm. absolute have been successfully used. The Bristol Co.

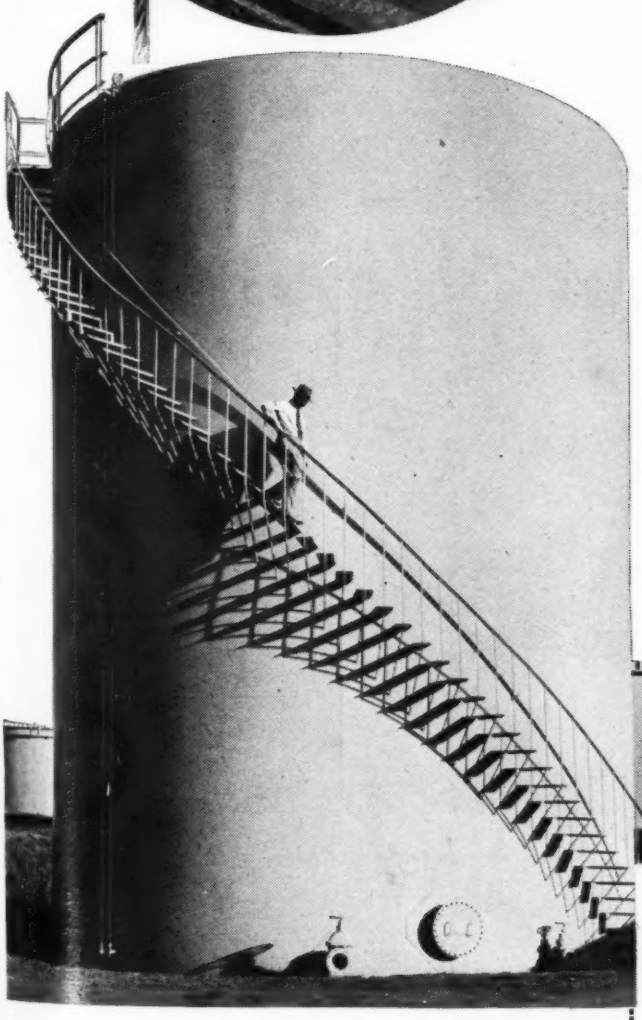


More "What's New!" Items, p. 1030

SWING AWAY from TROUBLE...

with swing pipe cable of corrosion-resistant MONEL





You know what happens when a swing line lets go, dropping your pipe to the tank bottom.

It's too late then to wish somebody had insisted on Monel* wire rope for the swing line.

But—fortunately—it's never too late to specify Monel for replacement.

Men familiar with the ways of beating refinery corrosion problems agree that you could hardly make a smarter choice. Here's why:

Monel, a solid Nickel Alloy, is corrosion resistant *all the way through.* And Monel wire rope is strong and tough; it is available in sizes to support and swing your largest pipe with maximum safety.

3-Way Protection

Monel wire rope stands up against the 3 corrosive areas that gang up on swing and gauge lines: stored fluid, vapor space, and atmosphere. Monel affords ample protection against all three!

You can see, then, how it happens that Monel line installations have outlasted their predecessors by many years.

For your next new storage tanks—or for your next replacement jobs — make sure your lines are Monel. Write us for further information about sources, prices and deliveries. And prepare for a pleasant surprise—you can actually save money by using Monel! Get the full story by mailing the coupon *now.*

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

*Reg. U. S. Pat. Off.

EMBLEM OF SERVICE

INCO TRADE MARK

LONGER LIFE—GREATER SAFETY. Monel swing pipe cables and gauge lines provide a high degree of resistance to the principal corrosives encountered in petroleum storage. *Photo by Libsohn, courtesy of Standard Oil Co. (N. J.).*

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

I'm sold on the advantages of Monel for swing pipe cable. If it'll save me money, too, I certainly ought to have all the facts. Without obligation, please send me information about prices, sources and deliveries.

Name..... MAIL TODAY .....

Company.....

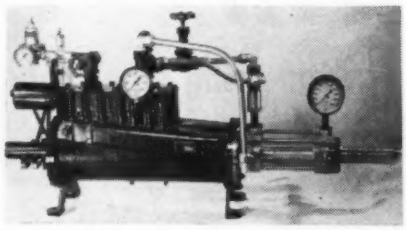
Address..... PP-9-49

City.....*Zone*.....*State*.....

MONEL...YOUR PARTNER IN PROGRESS

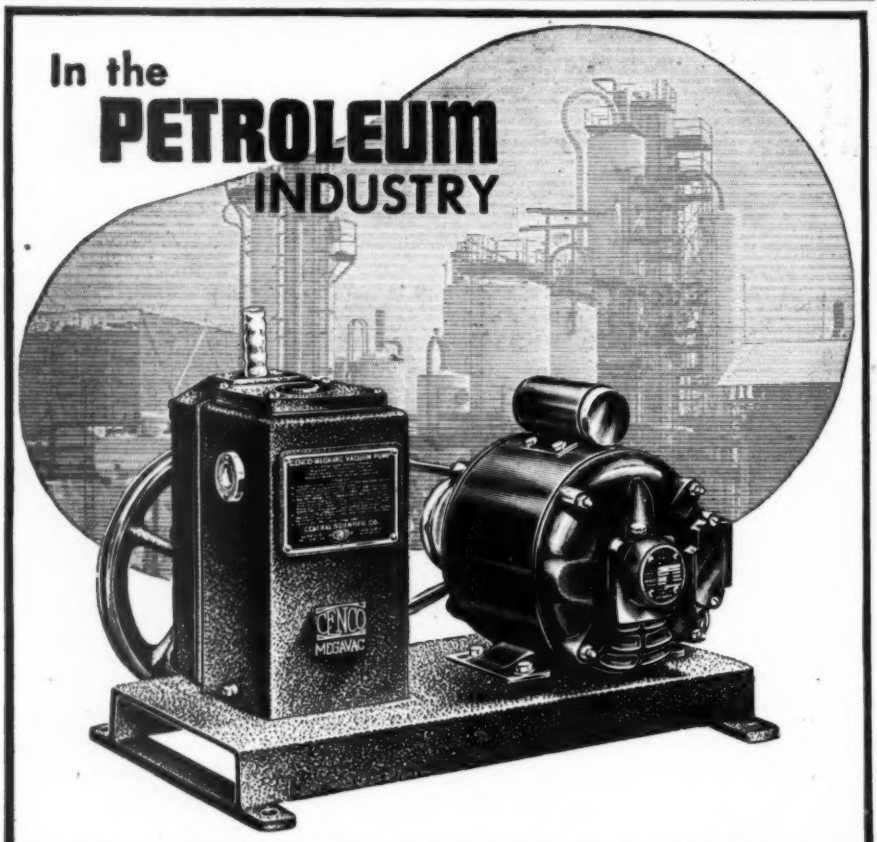
15—Hydraulically-operated Pump

The McFarland Pump is a double-acting, reciprocating pump operated by fluid pressure and design-based on the simple principle of hydraulics —that the force on a surface is equal to the product of the average pressure per unit times the total area. The pump provides hydrostatic pressures ranging from 0 to 20,000 psi. Non-sparking in operation, it is said it can be safely used wherever fire and explosion hazards are great. It



can be used for testing valves, high pressure fittings, pressure vessels, sump pump work, and chemical injection, among other applications. McFarland Mfg. Corp.

In the **PETROLEUM INDUSTRY**



THE CENCO-MEGAVAC PUMP

combines in a single mechanical unit high ultimate vacuum with high pumping speeds for fractional distillations, temperature and pressure measurements and other laboratory or pilot plant procedure which requires fast initial evacuation. This unit is proved for dependable and trouble-free service. Speed at 1 micron, 375 ml; vacuum, 0.1 micron or better.

Specify No. 92015A Cenco-Megavac Pump mounted with base and motor for 115 volt, 60 cycle AC operation . $195.00

(Also available with motors for other voltages and frequencies.)

Write Dept. B. E. for engineering Bulletin 10A "High Vacuum Equipment".

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CENTRAL SCIENTIFIC COMPANY

Scientific Apparatus · Instruments · Chemicals

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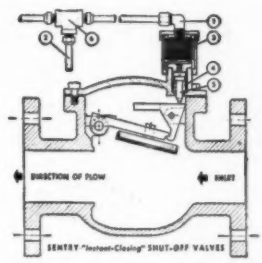
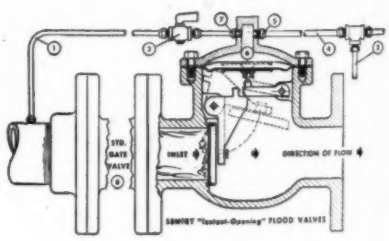
NEW YORK BOSTON SAN FRANCISCO NEWARK LOS ANGELES TORONTO MONTREAL

16—Automatic Dumping Valve

Two new valves have been announced which provide for automatic line control in the event of fire or other emergency. The "Sentry" Automatic "Instant-Closing" Shut-Off Valve will close all gas, fuel oil, or other "hot" lines entering the danger area. The companion Sentry "Instant-Opening" Valve provides a deluge of water at full line capacity, directed to any critical area requiring instantaneous flooding. Or it may be adapted to such other applications as automatic dumping of tanks or pressure vessels, full pressure feed for steam, fog, or CO_2 fire smothering systems, etc. The valves are connected to a small tube in which a nominal pressure is maintained. The valve mechanism closes the one valve (and opens the other) whenever the seal on the control line is broken. That may be accomplished by fusible seals, power failures, or other means. Valves are self - contained and not dependent on outside power or manual control. Sizes and types now available are: ¾, 1, 1¼, 1½-in. screwed ends; and 2, 2½, 3, 4, 6, and 8-in. flanged ends. McRae Valve Corp.

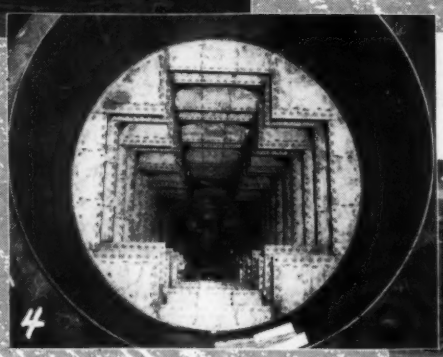


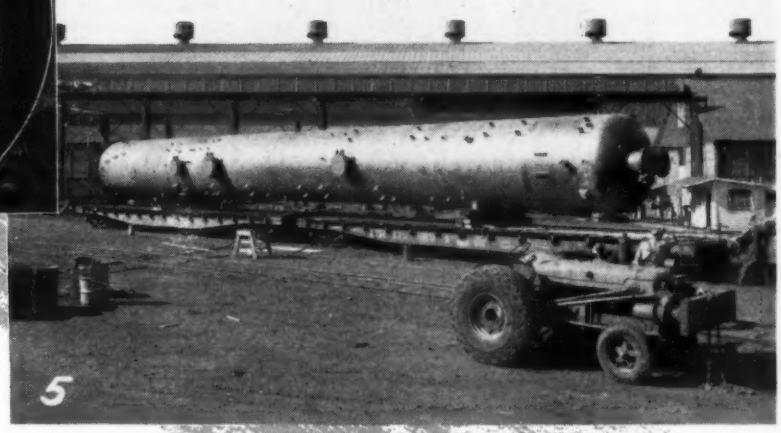


17—Safety Valve, Viscous Materials

Efficient operation of safety and relief valves handling viscous materials is made possible by a new internal heat exchanger design developed recently. The heater is a steam coil built into the valve body around the seat and guide, so that highly viscous materials are kept in a fluid state, and eliminating the need for costly and inadequate steam tracing. Farris Engineering Corp.

More "What's New!" Items, p. 1032





It takes *Steel and Skill* to make a "tailored" tower

. . . and good "tailors" are intimately acquainted with this combination. For at every step—preparing detail drawings, ordering plates to size, shearing and beveling the edges of the plates, and rolling plates to exact radii—the "tailor" must know the material and exercise skillful craftsmanship to produce—at reasonable cost—a tower that does the job.

The accompanying views demonstrate that CB&I is well equipped to fabricate specialized refinery equipment. To assist the men and equipment shown, we have special facilities for x-raying and stress-relieving pressure vessels. Certainly, welded steel plate structures produced by CB&I are "tailor-made" to meet your individual requirements.

In addition to towers and pressure vessels, CB&I builds many structures for the petroleum industry—including those familiar trademarks of high pressure storage, the Hortonsphere and Hortonspheroid. The next time you need steel plate work, write our nearest office for a quotation "tailored" to your requirements.

(1) The plate is being rolled into shape.
(2) Rolling completed with welding the next step.
(3) The inside seam of the ring is welded. (A stainless steel lining was also welded to the inside of the lower portion of the tower).
(4) Trays are installed in the tower.
(5) All finished and ready to go!

CHICAGO BRIDGE & IRON COMPANY

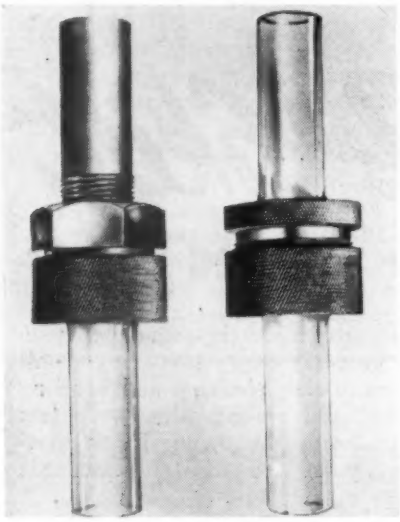
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

Atlanta 3 .....2103 Healey Building
Birmingham 1 .....1527 North Fiftieth Street
Boston 10 .....1029-201 Devonshire Street
Chicago 4 .....2114 McCormick Building
Cleveland 15 .....2215 Guildhall Building
Detroit 26 .....1532 Lafayette Building
Houston 2 ....2130 National Standard Building
Havana .....402 Abreu Building
Los Angeles 14 1526 General Petroleum Building
New York 6 .....3310-165 Broadway Building
Philadelphia 3 ..1630-1700 Walnut St. Building
Salt Lake City 1 1530 1st Security Bank Building
San Francisco 11 ..1208-22 Battery St. Building
Seattle 1 .....1330 Henry Building
Tulsa 3 .....1620 Hunt Building

REPRESENTATIVES AND LICENSEES

Horton Steel Works, Limited, Fort Erie, Ontario, Canada
Ateliers et Chantiers de la Seine Maritime, Paris, France
Constructions Metalliques de Provence, Arles-sur-Rhone, France
Compagnia Tecnica Industrie Petroli, S.A. 1, Rome, Italy
Whessoe, Limited, Darlington, England
Motherwell Bridge & Engineering Company, Limited, Motherwell, Scotland
Chicago Bridge & Iron Company, Ltd., Apartado 1348, Caracas, Venezuela

18—Glass-pipe Coupling



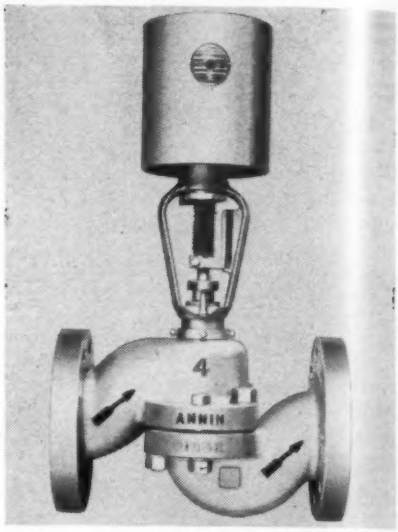
A new threaded metal coupling has been developed for use with Pyrex glass pipe lines. It is said to simplify the installation of glass piping by replacing three-bolt triangular metal flanges. Use of wrenches is no longer necessary and perfect alignment is assured. Time for installation is reduced up to 60% in comparison with alternate methods. Couplings are available from stock in sizes ¼, ½, ¾, and 1 in. for making glass-to-glass or glass-to-metal connections. Fischer & Porter Co.

19—Hardenable Stainless Alloy

Containing 17% Cr, 4% Ni, 4% Cu, Armco's new 17-4 PH stainless steel is said to have corrosion resistance approaching that of Type 304, 18-8, and superior to that of standard hardenable alloys. It can be treated by precipitation hardening at 900° F., lower than typical high-temperature hardening of standard alloys. This eliminates quenching cracks, distortion, stresses, and scaling. It is available as bar or wire, annealed or hardened. Armco Steel Corp.

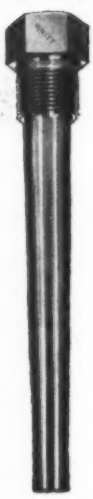
20—High-pressure Control

The Annin "1520 Series" Electro-pneumatic Solenoid Valves have been designed for controlling fluids at pressures up to 3000 psi. Using a secondary pressure source such as



air, gas, or liquid at normal pressures from 50 to 300 psi. through a 3-way pilot solenoid, the valves are furnished in sizes ¾ through 8 in. With an "Annico Teflon Seat Seal," they are available in the following alloys: carbon steel, Type 316 Stainless, Durimet 20, Hastelloy B, C, or D, nickel, and Monel. They are useful in handling liquid oxygen, fuming nitric acid, sulfuric acid, alcohol, helium, nitrogen, and hydrogen. The Annin Co.

Threaded Bar Stock
THERMOWELLS



Type T-100 Series
TRINITY Threaded
Bar Stock Thermowell

T-100 – 1" SPT – 3/8" bore for #14 Gauge Thermocouples.
T-101 – 1" SPT – 13/64" bore for #20 Gauge Thermocouples.
T-102 – 3/4" SPT – 3/8" bore for #14 Gauge Thermocouples.
T-103 – 3/4" SPT – 13/64" bore for #20 Gauge Thermocouples.

Sizes: 3½", 6", 8", 10", 12", 18", and 24" immersion length. Special orders up to 60" (T-100, T-102 only).

Wall thickness: 0.187" (T-100, T-102); 0.179" (T-101, T-103). Lagging extension available. Plug & Chain available.

T-100 Series Wells can also be adapted for use with primary elements other than thermocouples.

* * *

TRINITY manufactures all types of metal protecting wells for the primary detecting elements of all types of temperature indicating, recording and controlling instruments for a wide range of industrial applications

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TRINITY EQUIPMENT CORPORATION
496 Westfield Ave East, Roselle Park, N.J.
THERMOWELLS and Other Specialties for the Process Industries

Trade Literature

21—Furnace Construction

Suspended Enclosures Applied to Oil Refinery Furnaces, a 20-page booklet showing drawings and describing 10 typical enclosures and vessel linings for several types of heaters, A-frame, end-fired, upshot, cylindrical, as well as catalytic reactors. Bigelow-Liptak Corp.

22—Flexible Metal Hose

Atlantic Flexible Metal Hose, Catalog No. 100; covers recent developments in interlocking and seamless hose for high pressure service, for steam, petroleum products, and the like; includes test tables, recommended installation methods, and typical applications. Atlantic Metal Hose Co.

23—Automatic Gas Analyzer

Baird Associates, Bulletin XXXI: eight page bulletin describing a new automatic, recording, gas analyzer, which utilizes the infra-red absorption characteristics of gases to obtain continuous determination of the critical component in a gaseous stream: applications include control of butene-1 in isobutylene, CO in hydrogenation gases, etc. Baird Associates, Inc.

What's New!

24—Preventive Maintenance

Simplified Preventive Maintenance Control for Plant and Production Equipment; a six-page report on the use of systematic "Kardex" procedures for cutting costs and keeping proper records on preventive maintenance. Remington Rand, Inc.

25—Organic Chemical

Cyanamid New Product Bulletin, B-Chloropropionitrile; 12 pages of data on this material, now being offered in trial-lot quantities: it is slightly soluble in water, very soluble in most organic solvents, and has a boiling point of 174-176° C. at 752 mm. Hg. American Cyanamid Co.

26—Rotary Pumps

Roper Rotary Pumps, Catalog 950: covers complete line of positive displacement, gear-type pumps for handling LPG, gasoline, lube oils, heavy petroleum products through asphalts: sizes to 200 gpm.; pressures, 60 to 1000 psi. George D. Roper Corp.

27—Abrasion-resistant Alloy

How to Reduce Abrasive Wear with Thermalloy HC-250; a six-page folder covering physical properties of this material as compared with 13% manganese steel, ABK Metal, and white cast iron; includes field service data on case histories. American Brake Shoe Co., Electro-Alloys Div.

28—Carbon Pipe and Fittings

Karbate Pipe and Fittings, Catalog Sect. M-8800B; and Installation Manual, Catalog Sect. M-8801: gives chemical resistance of impervious carbon or graphite pipe and fittings, specification tables, ordering information, and instructions on how such equipment is to be installed. National Carbon Co., Inc.

29—Steam Trap Problems

Solving Steam Trap Problems, a 36-page booklet telling how traps are selected, used, and maintained; including recommended sizes, and helpful engineering graphs and tables. V. D. Anderson Co.

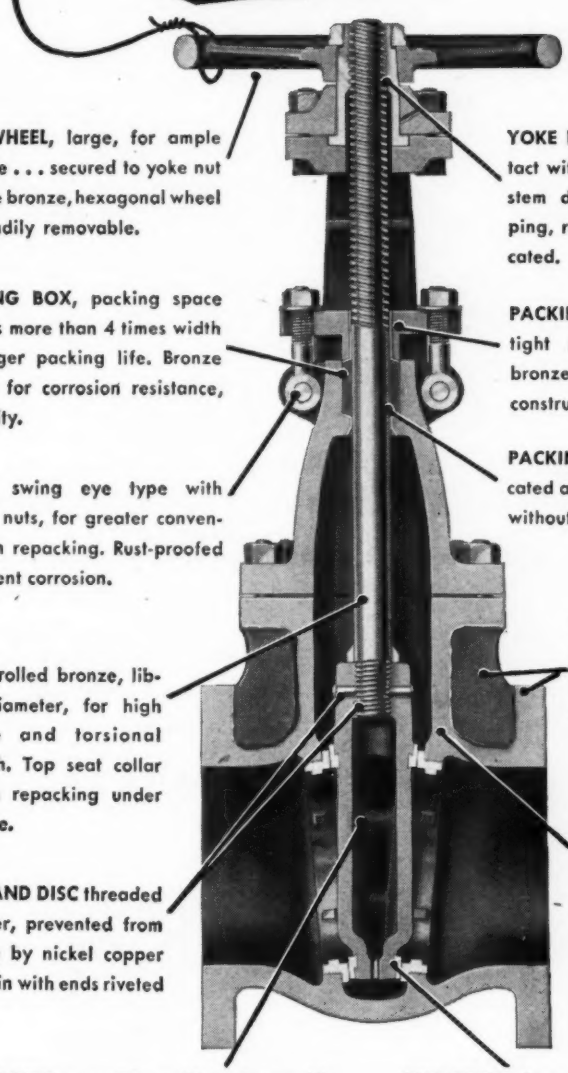
30—New Chemical Intermediate

Nitrosyl Chloride Properties and Reactions, Product Development Booklet NC-2: a 16-page paper by T. J. McGonigle, covering a chemical used at present as intermediate in the chemical synthesis of various products from crude petroleum as well as a number of other applications. Solvay Sales Division.

More "What's New!" Items, p. 1034

Precision Engineering Makes this KENNEDY VALVE Rugged and Dependable...

KENNEDY STANDARD IRON BODY WEDGE GATE VALVE
Fig. 0611, outside-screw-and-yoke. Service up to 125 lb. p.s.i. steam; 200 lb. p.s.i. water, oil or gas. 1½" through 48" sizes available.



HANDWHEEL, large, for ample leverage . . . secured to yoke nut by large bronze, hexagonal wheel nut, readily removable.

YOKE NUT, bronze, thread contact with stem at least 1½ times stem diameter eliminates stripping, reduces wear, easily lubricated.

STUFFING BOX, packing space depth is more than 4 times width for longer packing life. Bronze bushed for corrosion resistance, durability.

PACKING GLAND machined for tight seal with stuffing box, bronze-bushed at stem. Slotted construction simplifies repacking.

BOLTS, swing eye type with washer nuts, for greater convenience in repacking. Rust-proofed to prevent corrosion.

PACKING, molded rings of lubricated asbestos maintain tightness without excessive gland pressure.

FLANGES are heavy and well filleted. Flanged ends have reinforcing ribs for extra strength.

STEM, rolled bronze, liberal diameter, for high tensile and torsional strength. Top seat collar permits repacking under pressure.

BODY AND BONNET, Kennedy Higher Strength Cast Iron, generous metal thicknesses and well rounded corners provide maximum strength.

STEM AND DISC threaded together, prevented from turning by nickel copper alloy pin with ends riveted over.

WEDGE DISC, reversible and interchangeable, reinforced by integrally cast interior posts. Openings permit drainage in any position.

DISC RINGS, bronze, wide and thick, forced into dove-tailed grooves in disc to form practically integral construction.

Write for Bulletin No. 50. BUY FROM YOUR LOCAL DISTRIBUTOR

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1067 EAST WATER ST.
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VALVES • PIPE FITTINGS • FIRE HYDRANTS

OFFICE-WAREHOUSES IN NEW YORK, CHICAGO, SAN FRANCISCO • SALES REPRESENTATIVES IN PRINCIPAL CITIES

31—Pipe Tools

Beaver Pipe Tools, Catalog No. 49: 36 pages listing, and illustrating with photographs and functional drawings, a complete line of hand and electric power tools for cutting and threading pipe, bolts, and conduit; including specifications and price list. Beaver Pipe Tools, Inc.

32—Corrosion-resistance Data

Corrosion Resistance of Stainless, Monel, and Nickel Castings; a four page data sheet rating these several alloys in their ability to withstand some 100 different corrosive agents. Cooper Alloy Foundry Co.

33—Organic Intermediate

Nonyl Phenol, Technical Bulletin C-9-125, describes properties, chemical reactions, and uses of this alkylated phenol, now available in commercial quantities, and useful for producing surface-active agents, lube oil additives, corrosion inhibitors, insecticides, and the like. Koppers Co., Inc.

Precision--Dow Dual Recordomatic Titrometer

This apparatus will pay for itself within six months by providing: 1, Automatic control of reagent feeding and; 2, Automatic plotting of titration curves. And, apparatus has two complete titration set-ups.

This Titrometer is used for research, plant control, production control, in petroleum and chemical technology. Get all the facts by requesting your copy of Bulletin 640-A2.

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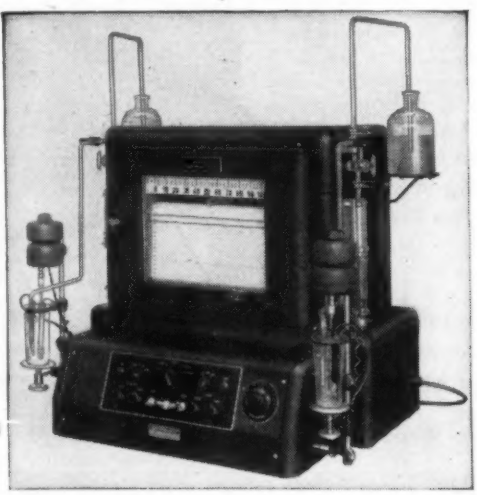
Precision—DOW DUAL RECORDOMATIC TITROMETER

Used to control the production of sulfur compounds, penicillin, chocolate, baking mixes, vegetable oils, soaps, fine chemicals, solvents and pharmaceutical products. Can also be used for the study of dissociation constants of acids and bases, relative strengths of oxidizing and reducing agents, etc. *Bulletin 640-A2 has the whole story. Request your copy.



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Scientific Research & Production Control Apparatus

OFFICES IN CHICAGO, NEW YORK, PHILADELPHIA AND SAN FRANCISCO

34—Level Gage Accessories

Optional Features and Accessories, Jerguson Gages and Valves, Data Unit No. 119: a four-page folder describing optional equipment available for use with line of liquid level gages. Jerguson Gage & Valve Co.

35—Water Analyses

Testing and Control Equipment for Water Analyses, 16 pages illustrating and describing apparatus and test sets designed especially for industrial water testing. W. H. & L. D. Betz.

36—High-pressure Refinery Pumps

Pacific Types I and Z Pumps for High Pressures and Extreme Temperatures, Bulletin 106: describes two models of multi-stage centrifugal pumps in sizes 2 to 8 in.; capacities, 100 to 2700 gpm.; speeds, to 5000 rpm.; pressures to 3000 psi.; one of which is centerline mounted on water-cooled pedestals for high temperatures, the other foot mounted for low temperature operation. Pacific Pumps, Inc.

37—Gaskets, Packing, Hose

Raybestos-Manhattan Products for Petroleum, Booklet No. 6903: a 16-page bulletin covering rubber and asbestos hose for ship and tank car loading, for butane, for fires, and still cleaning; and gaskets and packing in sheets, rolls, and rings. Raybestos-Manhattan, Inc.

38—Pipe Fitting Prices

Gates Engrg. Co. Net Price List; covers "Gaco" joints, pipe lining, lined pipe, 45 and 90° ells, tees, crosses (all lined); and flanges, lock rings, and gaskets. Gates Engrg. Co.

39—Finned Tube Prices

Wolverine Trufin Data and Prices, March 1, 1949: eight pages of catalog information and latest price list on a line of one-pieced finned tubing for heat exchangers, coolers, interchangers, condensers, and the like. Wolverine Tube Division of Calumet and Hecla Consolidated Copper Co.

40—Equipment Cleaning Methods

How to Cut Cleaning Costs in the Petroleum Industry: a 32-page, pocket-size pamphlet, telling how Oakite materials, methods, equipment, and service can be used to advantage in cleaning such equipment as heat exchangers, tanks, towers, tank cars, drums, and many others. Oakite Products, Inc.

More "What's New!" Items, p. 1036

Not Just "LOW-PRESSURE COMPRESSORS"

Two Worthington horizontal duplex opposed steam-driven RDV pumps (Type ODV) in the lubricating oil treating plant of a large refinery.

. . . but SPECIALIZED VACUUM PUMPS

Modern refinery practice demands the utmost efficiency in processing. And this efficiency can only be obtained with equipment that's *specifically designed for the job!* That's why, in refineries all over the world, WORTHINGTON is the top name in vacuum pumps.

These close clearance, high vacuum units are built with precision . . . Feather* Valves with hardened alloy seats and guards are the most efficient "breathers" made . . . extreme simplicity of construction gives unusual accessibility . . . top-grade materials insure greater ruggedness . . . conservative ratings give you abundant reserve power. No wonder, then, that in modern solvent extraction and solvent dewaxing plants WORTHINGTON vacuum pumps are the industry's first choice.

GET ALL THE FACTS

Worthington Horizontal Dry Vacuum Pumps are available in a variety of designs and drives permitting selection of the *right* unit to maintain the required vacuum at lowest operating cost. Bulletin L-710-B1B contains further facts proving *there's more worth in Worthington.* Write to *Worthington Pump and Machinery Corporation, Compressor Division, Buffalo, N. Y.*

WORTHINGTON

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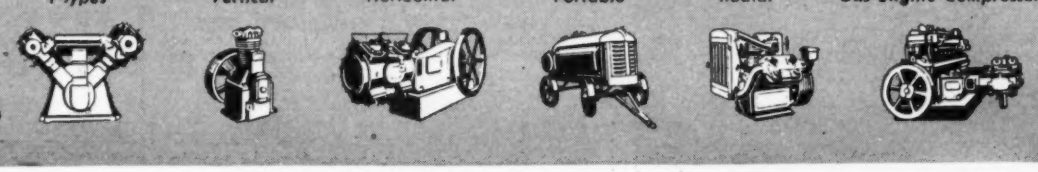
*Reg. U.S. Pat. Off.

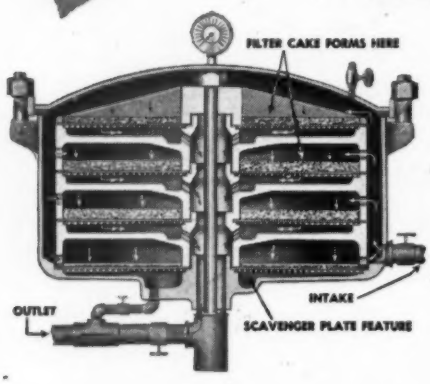
NO OTHER COMPRESSOR WILL OUTPERFORM A WORTHINGTON



Sparkler Filters

SPARKLER horizontal plate FILTERS

. . . keep petroleum products clean and free of foreign matter



The Sparkler horizontal plate method of filtration insures a firm, unbroken filter cake formed from diatomaceous earth or other filter media particularly suited to the liquid filtered. Such a filter cake removes even microscopic particles from any liquid ranging from light alcohols to heavy resin products.

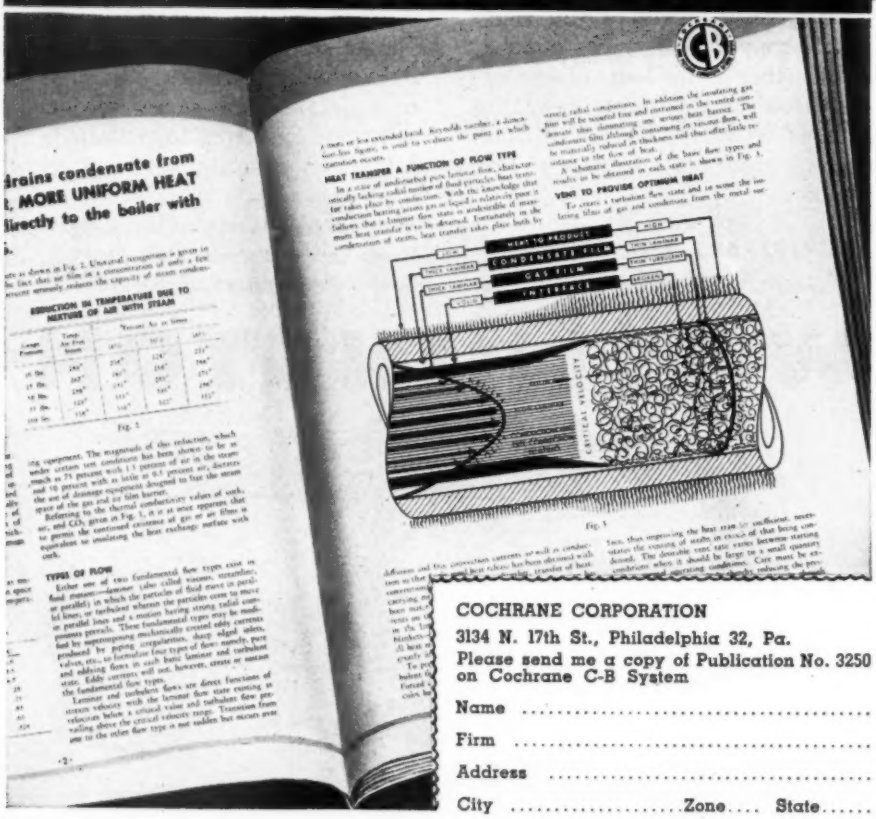
The petroleum refining and processing industry have available a filter in the Sparkler that solves many problems of keeping liquid petroleum products free from solids such as scale, rust, grit, and other foreign matter.

Domestic Fuel Oil *bulk plant operators can be sure of delivering clean clog-free fuel oil by filtering with Sparkler filters*

Sparkler filters are available in capacities from small pilot plant models to built-in production line units of 5000 gallons per hour. The services of our staff of engineers with over a quarter of a century experience in solving filtration problems is available. Your problems will receive personal attention and individual analysis. Write Mr. W. J. Kracklauer, Sec'y & Treas.

SPARKLER MANUFACTURING COMPANY, Mundelein, Illinois

If you use process steam you'll want this valuable book—



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What's New!

41—De-scaling Exchanger Tubes

The Mechanical Cleaning of Fouled Heat Exchanger Tubes, a reprint of a paper from an annual meeting of the American Society of Mechanical Engineers by Mr. A. John, assistant general manager, Thomas C. Wilson, Inc.

42—Alloy Castings

Duraloy High Alloy Castings, Bulletin 3049; describes static and centrifugally cast alloys of chrome-iron, chrome-nickel, and nickel-chrome giving design stress curves, and tabulating applications and characteristics, including oxidation and corrosion resistance, machinability, weldability, and high temperature strengths. The Duraloy Co .

43—Stainless Steel Treating

Heat Treating and Pickling of Armco Stainless Steels; a 36-page booklet presenting comprehensive information on this type of treatment for stainless steels, recommended practices, special procedures, and the like for chromium-nickel, ferritic chromium, and martensitic chromium types, including charts and graphs of the effect of various heat treating methods on the mechanical properties. Armco Steel Corp.

44—Temperature Recorders

Auto-Lite Indicating and Recording Thermometers, a four page descriptive folder with specifications for five types of thermometers, accessory bulbs and fittings, stationary and portable types. Electric Auto-Lite Co., Instrument and Gauge Division.

45—Jacket Water Coolers

Coolers for Gas, Gasoline, and Diesel Engines, Catalog No. 1349: 14-page booklet, including dimension tables and drawings, capacity tables, on coolers ranging up to 2,270,000 Btu./hr. sizes. Young Radiator Co.

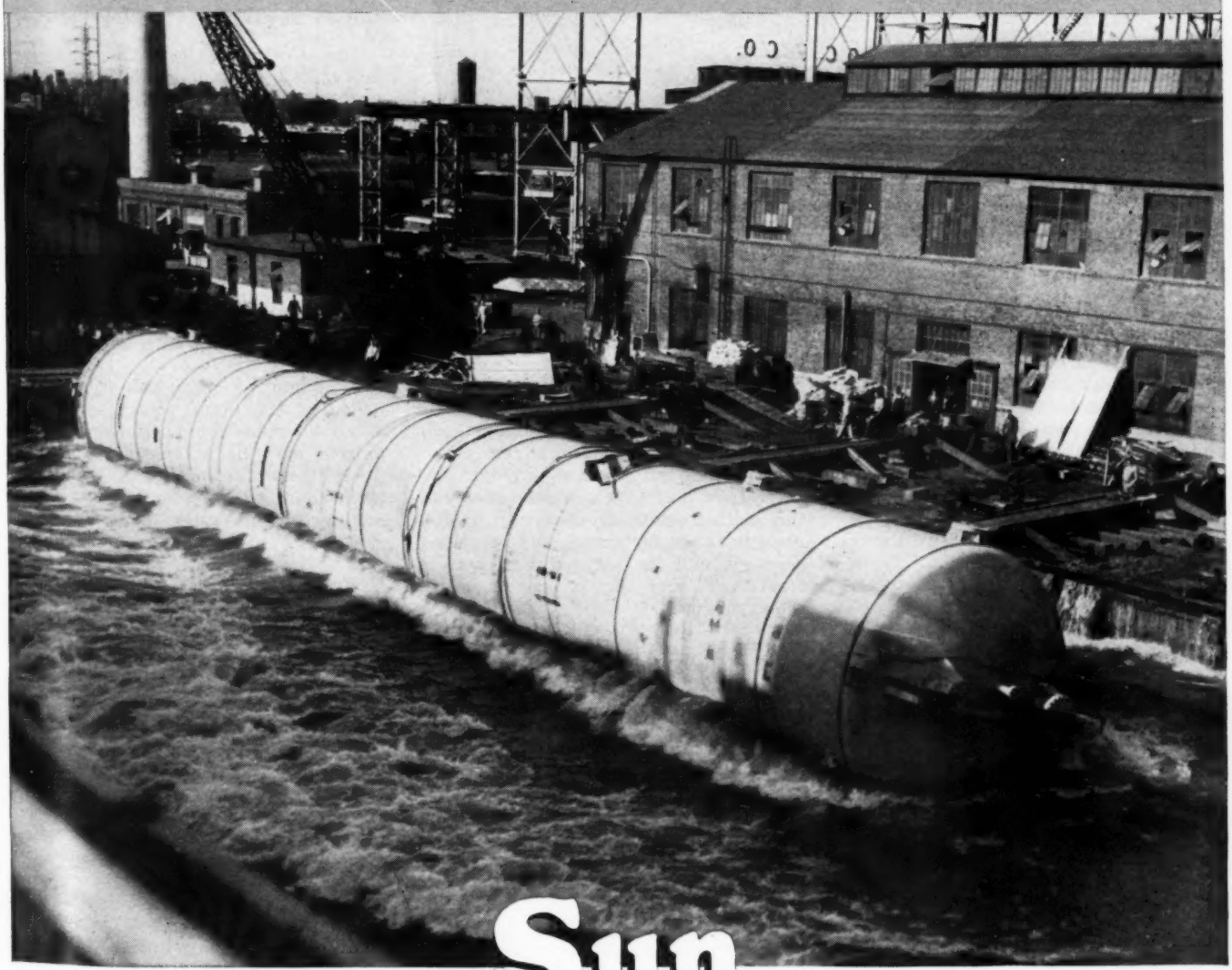
For Your Convenience

Business reply cards are included in this issue of PETROLEUM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing page 1025. Just circle the numbers corresponding to the numbers on the items you're interested in, fill in the bottom of the card, and drop it in the mail. No postage required.

Launched . . .

. . . for shore duty

Besides having the know-how and facilities for fabricating every kind of refinery and chemical plant equipment, Sun is ideally located. Sun-built units such as this tower, too large to be shipped by rail, can be transported by water—floated or carried as deck loads or on barges . . . Here, too, on the deep Delaware River, Sun builds its famous tankers and cargo vessels.



Sun

SHIPBUILDING & DRY DOCK COMPANY

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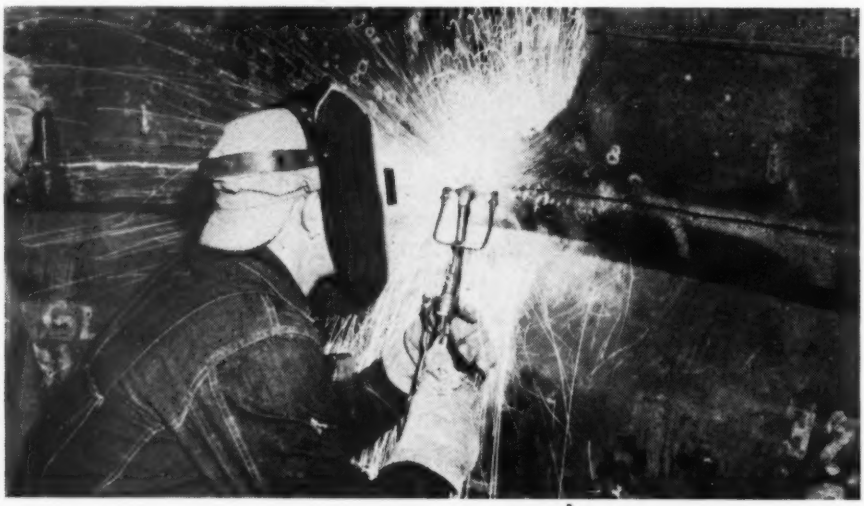
NEWS OF

Manufacturers—Suppliers—Engineering Firms

Serving the Petroleum Processing Industry

Powder-cutting Technique Used on High-alloy Steel in Refinery



Using powder-cutting accessories on an oxy-acetylene cutting blowpipe, operator makes circumferential cut through in.-thick alloy steel wall of refinery catalytic tower

Powder-cutting technique solved a difficult problem in refinery construction recently at one midwestern plant. The inner chamber of a large catalyst tower, proved to be 3½ in. too long. The material was 12% chrome-steel alloy, 1 in. thick. As well as shortening the column, it was necessary also to cut eight circles in the inner chamber to allow heat to pass into the outer chamber while the entire tower was stress-relieved in position. These holes were welded back after treatment.

By the use of powder-cutting, a process developed by **Linde Air Products Co.**, the job was done in two days. In all, about 70 ft. of the alloy material were cut. The process, designed to cut material such as stainless or high-alloy steels, oxidation-resistant to the normal oxy-acetylene flame. An iron-rich powder is blown into the oxygen stream from outside the preheat flame. This powder is heated to ignition temperature by the preheated flame, the ignition creating a high temperature reaction. As the cutting proceeds, a combined melting and fluxing action continuously removes any refractory oxides formed.

Graver Sets up Water Conditioning Co.

The establishment of the **Graver Water Conditioning Co.** as a division of **Graver Tank & Mfg. Co., Inc.**, has been announced by President E. N. Gosselin. Move was made, it is said, to extend the operations of company's water conditioning and process equipment department. Products include hot process softeners, deaerating heaters, zeolite softeners, cation and anion exchangers, demineralizers, clarification and filtration equipment, reactivators, and chemical feeders. Complete technical, chemical, engineering, manufacturing, and erection services will be offered for water treatment and liquid conditioning requirements.

GlenLab to Build Project 6 Still

Glass Engineering Laboratories, 561 O'Neill Ave., Belmont, Calif., has been selected to design and manufacture a commercial laboratory model of the rotary concentric-tube distilling column developed by Willingham, Sedlak, Westhaver, and Rossini of the American Petroleum Institute Research Project 6 at the National Bureau of Standards.

The first commercial model will be tested by Project 6. After approval, units will be made available to API members and others interested in obtaining the new equipment. The model will have an annular space of 1 mm., with a cylindrical rotor 5 in. in diameter and 5 ft. in length, operating at either 4000 or 8000 rpm. The original test model has about the same annular space with a rotor 3 in. by 2 ft., operating at 4000 rpm.

On the basis of successful tests on the original model, it is calculated that the commercial model, operating at 8000 rpm., will yield 500 equivalent theoretical plates at total reflux at a throughput of one gal. liquid per hour, at a distillation pressure of 1 atmosphere. Correspondingly, for a speed of 4000 rpm. and a throughput of 2 gals/hr., the plates at the same conditions is 135.

Dulien Buys Cotton Valley Refinery

The Cotton Valley, La., refinery designated as Plancor 592 has been purchased for liquidation from the federal government by **Dulien Steel Products, Inc.**, and is being offered for resale as a whole unit or piece by piece. The major processing facilities, installed for producing alkylate, comprise a dehydrogenation unit, an HF alkylation unit, and a tetraethyl lead blending plant. Appraised in 1947 at a reproduction cost of nearly $7½ million, the plant today is said to have a re-use value of nearly $2 million.

A liquidation office has been established at the plant, which is located about 45 miles from Shreveport. Inquiries may be addressed to Dulien Steel Products, Inc., P. O. Box 1787, Shreveport, La., or phoned directly by calling Cotton Valley 26.

New Radiochemicals Available

Fifteen new radiochemical compounds tagged with Carbon-14 now are available from **Tracerlab, Inc.**, 130 High St., Boston 10, Mass., it has been announced. This increases the total list of available organic radiochemicals to 24.

The additions are: ring-labeled toluene, ring-labeled benzoic acid, benzene, methyl-labeled sodium acetate, methyl-labeled ethyl acetate, methyl-labeled ethyl alcohol, methyl-labeled ethyl iodide or bromide, carboxyl-labeled glycine, carboxyl-labeled alarine, methylene-labeled hexo-ethyl-tetraphosphate, methylene-labeled triethylphosphate, carboxyl-labeled benzoic acid, methylene-labeled glycine, carboxyl-labeled bromoacetate, and carboxyl-labeled 2, 4-D.

These compounds can be obtained direct from Tracerlab after Atomic Energy Commission approval has been obtained. In most instances the specific gravity is one millicurie per

NOW IT'S HERE...*the New "VAREC" Electronic Gauger!*

COSTS YOU LESS

Initial costs are lower because the new electronic design eliminates Selsyn Motors. Installation costs are less because fewer and smaller wires are used.

GIVES YOU GREATER ACCURACY

Accuracy is only limited by types of float gauge used. Measures liquid level to ± 1/16" with "VAREC" 253 Series Automatic Tank Gauges. Not affected by wide line voltage variations.

PROMOTES SAFETY

No climbing on slippery tanks during wet or icy weather. No danger from toxic vapors. Low voltage, low current transmitter completely isolated from tank vapors.

EASY TO OPERATE AND MAINTAIN

You need only select the tank to obtain an accurate continuous gauge reading. You need only push a button to instantaneously check receiver adjustments. It is not necessary to reset instrument after power failure.

GREATER VERSATILITY

Transmitters may be installed on tanks already equipped with suitable float-type gauges. Small, compact receiver may be located on desk or panel mounted. Readings may be made at more than one remote position by installing additional receivers. High-low level alarms or controls may be added to the receiver without running additional wires to the tanks.

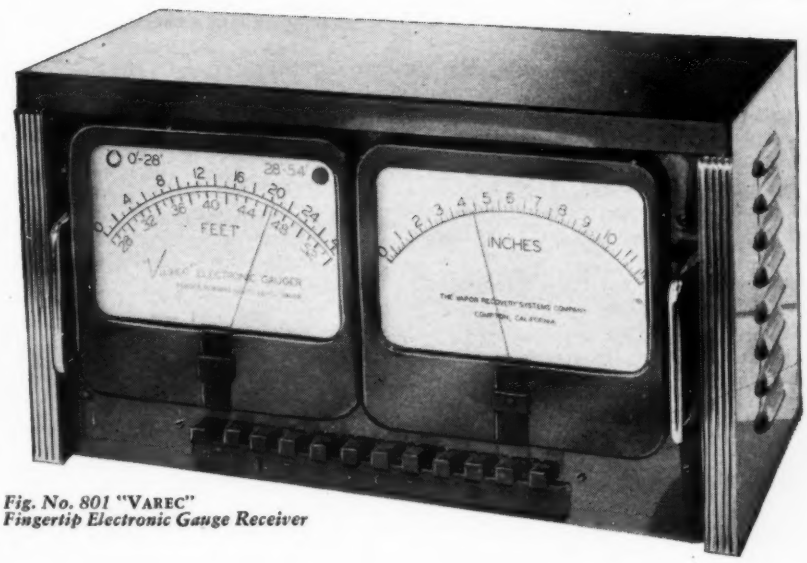


Fig. No. 801 "VAREC" *Fingertip Electronic Gauge Receiver*

REMOTE LIQUID LEVEL GAUGING AT ITS BEST!

Now you can gauge your tanks accurately to within ± 1/16" of tank level on a centrally located panel. The new "VAREC" Electronic Gauges enable you to duplicate tank gauge readings at any location... gives you greater accuracy when installed with "VAREC" Automatic Tank Gauges. Eliminates traveling throughout the tank farm or gauging tanks outside during bad weather. Eliminates the dangers of toxic vapors. Eliminates the errors from the human element in gauging.

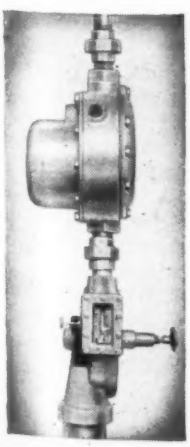
MULTIPLE OR SINGLE TANK RECEIVERS

Multiple Tank Receivers, for individual gauging up to 10 tanks or up to 24 tanks; On-Gauge Receivers for individual tanks or simultaneous gauging. The front panel of each receiver has two dials. Feet indications from 0 to 54 feet are read on the left-hand dial and inch indications from 0 to 12 inches by 1/8" increments are read on the right-hand dial. Proper reading of the foot scale is designated by two colored pilot lights at the upper corners of the dial. The receivers are designed for use on 110-115 volt, 50-60 cycle, a-c power.

EXPLOSION-PROOF TRANSMITTERS

Transmitters are available in four designs to meet tank working pressure requirements. All are designed to be explosion-proof, suitable for use in Class 1, Group D, hazardous locations.

Fig. No. 850 Electronic Gauger Transmitter installed above lookbox of "VAREC." *Fig. No. 253 Automatic Tank Gauge.*



PROVED and APPROVED "Varec"

THE VAPOR RECOVERY SYSTEMS COMPANY
NEW YORK PITTSBURGH CHICAGO TULSA HOUSTON
COMPTON, CALIFORNIA, U.S.A.

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NAME_____ TITLE_____

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Send for Your Copy of "Remote Gauging at Its Best" Today!

SEE THE "VAREC" ELECTRONIC GAUGER AT THE I.S.A. INSTRUMENT EXHIBIT IN ST. LOUIS SEPTEMBER 12-16

millimol. The company also is in a position to undertake special synthesis work on a contract basis for those interested in other radiochemical compounds.

Western Expands Activities

Expansion in both heat exchanger sales and engineering and sales personnel has been announced for **Western Supply Co. of Tulsa,** according to J. E. Hughes, manager of the Heat Exchanger Division in the home office.

A branch office has been opened in the West Bldg., Houston, Texas, with Frank M. Gibbons as exchanger division representative for the Gulf Coast area. Gibbons was formerly with the Bechtel Corp., and prior to that, American Locomotive Co. Paul R. King will continue to represent the company at Houston in pipe, valves, and fittings.

Simultaneously, E. D. Anderson, with Western since 1947, was appointed to the post of chief engineer of the exchanger division. Anderson

Mr. Gibbons

Mr. Anderson

obtained his training at Wisconsin University after which he spend five years with Shell Oil Co. at their Wood River refinery.

Western Supply has just recently been voted into membership in the Tubular Exchanger Manufacturers' Association, a group of manufacturers serving the refining, gasoline, and general processing industries, and responsible for the development of thermal and mechanical standardization of tubular heat transfer equipment.

Vacancies in Instrument Course

A number of vacancies have been announced in the next **Fischer & Porter Co.** instrumentation course, to be held at the Hatboro, Penna., plant, Oct. 10 through 14, 1949.

The course will cover the manufacture, calibration, installation, operation, and maintenance of the company's "Flowrator" primary and secondary process control instruments. Some time is devoted also to the basic principles of variable-area flow measurement. The course is designed for engineers responsible for process control instrumentation.

Some guest accommodations in Hatboro are available by pre-arrangement and there are frequent trains to Philadelphia, about 18 miles away. Further details can be obtained from the Fischer & Porter Co., East County Line Road, Hatboro, Penna.

Peabody Names General Manager

Eric G. Peterson has been appointed general manager of **Peabody Engrg. Corp.,** manufacturers of fuel combustion equipment, gas scrubbers, gas coolers, and direct fired air heaters. Mr. Peterson will continue as general sales manager of all products in all divisions.

Mr. Peterson

A graduate of Stevens Institute of Technology, he served as an engineer officer in the U. S. Navy during World War I, joining Peabody in 1928 after several years in power plant work in South America. His headquarters will be at the firm's executive offices, 580 Fifth Ave. New York City.

Richardson Joins Ridge Tool

L. C. Richardson has been appointed sales representative of **Ridge Tool Co.'s** Inter-mountain territory. States under his supervision are Missouri, Kansas, Colorado, Arkansas, Wyoming. His headquarters are in St. Louis. Mr. Richardson's previous experience in the pipe-tool field includes 13 years with the Stockham Pipe Fittings Co. and the Grinnel Co., with activities centered in the South and West.

Expansion, Transition

The Refinery Manufacturing Co., Tulsa, has been incorporated to offer engineering, development, and manufacturing facilities for scientific, laboratory, and gas measurement equipment. Formerly the R. S. Mfg. division of **Refinery Supply Co.,** the new concern is headed by W. A. Schlueter, president of Refinery Supply.

Thomas Bryan & Associates Inc., a Houston engineering and construction firm, has announced completion of a working agreement with Nippon Kihatsuyu Kabushiki Kaisha (Japan Gasoline Co. Ltd.), to collaborate in the engineering design and reconstruction of Japan's chemical processing and petroleum refining industries. Among plants presently on the joint program are three small fatty oil refineries, two margarine-butter plants, an alcohol plant, paint plant, and several others.

Vapor Heating Corp., Chicago, has acquired controlling interest in **Texteam Corp.,** Houston. Texteam manufactures a line of safety relief valves, liquid injector pumps, etc. and now will make a large, heavy-duty steam generator designed by Vapor Heating engineers. A J. Loose, until recently associated with Vapor's Chicago plant, has been elected vice president and treasurer of Texteam and will be in active charge of operations.

Selas Corp. of America, Philadelphia, has taken over the industrial dehumidification equipment activities of **Davision Chemical Co.,** Equipment Section, Engrg. Div., Baltimore. R. S. Van Note, formerly manager of Davison's equipment section, has joined Selas as manager of the new Dehydrator Division. Design, production, sales, and service on Davison silica gel dehydrators will be offered now by Selas.

Barton Instrument Co., 3500 Union Pacific Ave., Los Angeles, has begun construction on a new and larger plant located at 1429 So. Eastern Ave. It is expected that occupancy will begin about July 15.

Other Personnel

Brown Instrument Division, Minneapolis-Honeywell—Charles E. Sharp has been made Chicago branch industrial manager, replacing John A. Robinson, named regional sales manager for the Midwest, Northwest, Rocky Mountain, and Pacific Coast areas. Both men started with Brown at the Philadelphia main plant 20 years ago, and both will make headquarters at Chicago.

Dowell Inc.—Marvin E. Johnston, Larkin L. Blake, and Clarence R. Olson, Jr. have been promoted to sales engineers. Johnston, with Dowell since 1943, is stationed at Pratt, Kans. Blake, who came to the firm in 1944 following several years as a refinery superintedent, is located at Lafayette, La. Olson, now at El Reno, Okla., joined the organization in 1947. A new station has been established at Sullivan, Ind., with B. E. McCann, from Flora, Ill., in charge.

American Steel & Wire Co.—Three sales officials have been placed in newly-established posts of area managers of sales. Eastern area post, with headquarters in New York, will be filled by Roswell F. Curtis, a 29-year veteran and since 1945 manger of manufacturers' products sales division. Appointed to a similar post for

Where WeldOlet is attached to run pipe, it tapers at proper angles, providing for a single bevel groove joint at the crotch section, blending into a V-butt joint at the ear portion.

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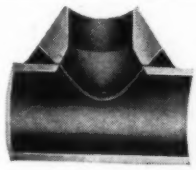

Fig. 1—Cut-away view of reducing size WeldOlet with welding outlet in place. The external rib and wide bases or footings of WeldOlets* eliminate the need for *extra supports* to take care of bending or vibrational stresses at crotch section, the point of greatest stress.

Fig. 2—Note blending of ear portion of welding fitting to run pipe. Extension of weld metal below inside scarfed portion of pipe insures all sections of joint greater than pipe wall thickness.

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FOR WELDED BRANCH PIPE OUTLETS

When you want Bonney Welding Outlets, ask for WeldOlets*

the Central area, with headquarters in Cleveland, was Howard B. Maguire, with the firm since 1919 and Detroit sales manager since 1933. Named Western area manager of sales, headquartered in Chicago, was Clarence T. Gilchrist, who started as a cashier's clerk with the company 42 years ago.

Graver Tank & Mfg. Co. and **Phoenix Mfg. Co.**—Engel E. Devendorf, recently returned from residence in South America, has been appointed export manager for both companies. He was formerly New York manager of Western International Corp. Graver's export program in south America, the Far and Near East, and Africa has been enlarged to include newly designed water processing equipment, specialized tank and vessel construction, engineering, and erection.

Worthington Pump & Machinery Corp.—John P. McArthur has been named manager, West Coast sales, with headquarters in San Francisco. He will supervise the activities of the Los Angeles, San Francisco, Seattle, and Salt Lake City district offices. With the firm since 1936, he has been manager of the San Francisco office the past four years.

General Refractories Co.—Harry T. Graham has been appointed assistant general sales manager. He has been with the company since 1937, and has seen service in sales offices in Chicago, Pittsburgh, and the main office at Philadelphia.

U. S. Industrial Chemicals, Inc.—Thomas H. Casson has been elected vice president and controller. He joined USIC in 1941 as general auditor, and has served as controller since 1945.

Branches, Distributors

C. J. Tagliabue Corp. has announced the appointment of the following district sales representatives: Ambos-Jones Co., Cleveland; Buler and Land, Dallas; Lynn Elliott Co., Houston; Curtis H. Stout, Little Rock; Geeseka and Pinkney, Minneapolis; Joralemon, Craig & Co., Philadelphia; J. E. Redmond Supply Co., Phoenix; Riddle and Hubbell, Tulsa.

Reynolds Metals Co. has established an office at 310 Thompson Bldg., Tulsa, with L. E. Pennington in charge. New branch will serve petroleum industry users of aluminum in piping, tubing, heat exchange equipment, and the like.

William F. Klemp Co. of Chicago, fabricators of structural steel footwalks, grating, treads, and "Hexteel" Surface Armor for ganister lining in catalytic cracking units, has opened a new plant at 7700 Wallisville Rd., Houston, to increase its service in the Gulf Coast area. Sales representative will be H. L. Thompson, for 20 years Houston representative for the main plant at Chicago. Mr. Thompson will continue to headquarter at Suite 414, Esperson Bldg.

Pittsburgh Coke & Chemical Co. has appointed the S. D. Day Co., Houston, as Southwest representative for "Pittsburgh" Protective Coatings."

Chain Belt Co. has opened a new warehouse in conjunction with expanded facilities for the Dallas district sales office at 1611 Dragon St., Dallas.

Dallas Mfg. and Sales Co., Dallas, Texas, has been announced as sole distributors in the U. S. and all foreign countries for "Gro-Cord" pipe repair gaskets, which formerly were marketed by the Gro-Cord Rubber Co., Lima, Ohio.

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Gasoline and Cycling Plant Operation

Conducted by DAVE THORNTON

The first four Questions and Answers presented here conclude material taken from a wire recording of the "Information Please Session" during the 28th Annual Convention, Natural Gasoline Assn. of America, April 22, 1949. With the remainder, this section resumes answering questions of natural gasoline and cycling plant operators. Readers are invited to submit queries on problems in their own work.

What are the efficiencies and operating temperatures of the Houdry gas turbines?

The turbines referred to are used in connection with the Houdry catalytic cracking process, a particular application for which it is difficult to express a thermal efficiency. If you are familiar with this, you will recall there is very little actual excess power developed. The compressor discharge is connected to the process, so by the time the compressed air has gone through the catalyst cases and returned to the turbine as hot gas it has suffered something like a 12 psi. pressure drop. The initial discharge pressure is approximately 45 psig.

Consequently, it is plain that much of the energy has been consumed in the form of that pressure drop and there is only a small excess of energy remaining over that required to drive the compressor. Therefore the overall thermal efficiency is very low. The maximum turbine operating temperature is approximately 900° F.

A unit designed today primarily for power generation purposes, however, would be constructed for operating temperatures in the neighborhood of 1300° F. and an operating life essentially comparable with a steam turbine. We can talk thermal efficiencies ranging anywhere between 20 to 35%, depending on the auxiliaries which might be desirable, such as intercoolers, regenerators, reheaters and the like.—J. T. Rettaliata, Consultant, Allis-Chalmers Mfg. Co., Milwaukee, and Dean of Engineering, Illinois Institute of Technology, Chicago.

How do you dry a tank which has contained wet propane?

Presumably the questioner has reference to a tank car. Tank cars now are of fusion welded construction, generally, although some riveted cars may still be in use. In the fusion welding process, a small ridge is built up between each ring of steel from which the tank is fabricated. This tends to form a low dam behind which free water tends to collect.

The only way this water may be removed is to open the manhole cover plate, enter the tank, and mop up the water. Tanks which have no access opening are a more difficult problem. The only method I can think of for them is to set up a circulating flow of liquid through the tank and continue the circulation until the water has been removed.—J. K. Smith, Field Engineer, LP-Gas Assn., Inc., Chicago.

How small in horsepower have you built gas turbines?

The smallest gas turbine has been probably of the order of 50 to 100 hp. I do not say I would recommend building one that small, but it has been done. The British have a unit or two they are advocating for automotive use, which will run somewhere around 100 hp. The Boeing Aircraft Co. also have built some small units; and during the war Allis-Chalmers Mfg. Co. built an axial flow compressor which if used in a power unit would have resulted in approximately 300 hp.

When these units are built in the very small sizes, however, one is undertaking a rather difficult assignment. It should be remembered that the useful horsepower derived from the unit is the difference between two relatively large powers. In other words, the turbine itself might develop 400 hp., for example, but the compressor which it drives requires approximately 300 hp. Consequently the excess—or useful power—in that case would be 100 hp.

When you get into small sizes, it is increasingly difficult to build efficient compressors and efficient turbines. If you should be "off" in the wrong direction on efficiency in either of these two elements an embarrassing situation might develop wherein the anticipated power simply is not realized. Therefore it is preferable to construct relatively large units in which minor unattained design expectations will not materially affect the actual, developed power.—J. T. Rettaliata, Consultant, Allis-Chalmers Mfg. Co., Milwaukee, and Dean of Engineering, Illinois Institute of Technology, Chicago.

What is the maximum size vessel for propane storage?

I wish I could tell you how to build some 100,000 bbl. propane tanks and store the product for about $2 or $3 per bbl., but so far no one has been able to solve that. Designs have been prepared for propane storage tanks with capacity as high as 80,000 bbl. and 200 psi., working pressure and there is no reason why some time in the future tanks of that size will not be built. In the very near future probably some propane storage tanks as large as 5,000 to 10,000 bbls. designed for 200 psi., basis API-ASME Code, will be built.—E. P. Shelton, District Sales Manager, Chicago Bridge & Iron Co., Tulsa.

What is the oil retaining efficiency of a mist extractor when located in the top of an absorber, compared to location in the outlet of the residue gas scrubber? Trouble is being experienced with an extractor in the latter location.

Theoretically there is no reason why a mist extractor will not work equally well in either location if properly installed according to the manufacturer's instructions. We prefer to install them in the top of the absorber. Installed elsewhere, additional expense is involved in providing piping to return recovered oil to the absorption system.

In this particular case, the extractor may be of too small capacity or improperly installed. Under the circumstances it may be advisable to install another extractor in the absorber, leaving the existing scrubber ex-

tractor in place. A recommended type is manufactured by the Peerless Manufacturing Co. for absorber installation, which fits over the outlet nozzle with a downcomer giving a liquid seal on the top plate of the absorber. —Harold Bottomley, The Refinery Engineering Co., Tulsa.

* * *

For the situation outlined by the questioner, in all probability the difficulty with the mist extractor is physical. The downcomer pipe on the existing mist extractor may be too small, or plugged, and first should be checked to insure that collected liquid is properly removed. Otherwise, this liquid will build up and actually be slugged into the outgoing gas stream.

Assuming the present mist extractor rather than the absorber is at fault, we suggest two solutions:

1. Check the capacity of the present mist extractor, being sure to take into consideration the specific gravity and temperature of the gas. If the size is too small, remove and install an extractor of adequate capacity.

2. Install a line separator on the residue gas scrubber outlet. The pressure drop across the line separator should be as low as possible, to prevent liquid build up in the downcomer, causing carryover. This will require only a minor piping change the first time the plant is down for maintenance or repair.

We should like to clarify any confusion which may exist between the term "mist extractor" and "line separator." The term "mist extractor" refers to a combination of one or more "vane units" installed within a vessel —such as an absorber or scrubber— to prevent carryover of mechanically entrained liquid. The term "line separator" refers to an external vessel of suitable size, containing a single "vane unit" and is used specifically to remove mechanically entrained liquids. It is installed in a line.

As each device has the same type of "vane unit" they work equally well and it may be left to the designer's discretion as to which is used. The mist extractor is less expensive because the external vessel is not required. However, many designers prefer the line separator where unusual conditions prevail. If the "vane unit" is located at the outlet of the residue gas scrubber advantage may be taken of the fact that the gas temperature is lower than in the absorber.

In the event the present mist extractor is at fault either of the alternative solutions presented will provide an efficient recovery of mechanically entrained liquid.—D. B. Mathey and J. S. Osborn, Allan Edwards, Inc., Tulsa representative for Peerless Manufacturing Co., Dallas.

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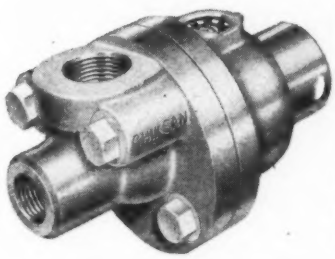

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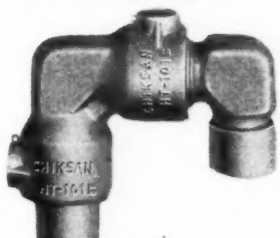

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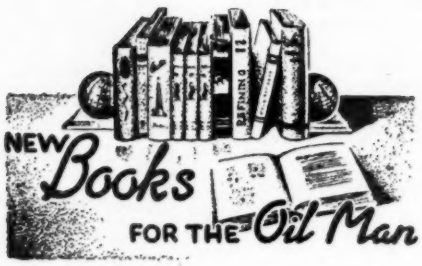

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Replacement-Addition Sheets for Vol. II, No. 1: 132 pages, $4.50; for *Vol. II, No. 2*: 232 pages, $6.75.

Replacement-Addition Sheets for Vol. III, No. 1: 196 pages, $6.50.

The *Encyclopedia of Hydrocarbon Compounds, Vols. III* and *IV*, now have been published, covering the C_8 and C_9 hydrocarbons. These supplement the first two volumes, which covered respectively C_1 to C_5 and C_6 and C_7 hydrocarbons, extending the value of this important reference material. The earlier volumes were described in *National Petroleum News Technical Section*, June 5, 1946, p. R-477, and PETROLEUM PROCESSING Sept., 1947, p. 713.

Format and style of the latest additions to the series conforms with the earlier volumes. All known compounds having eight or nine carbon atoms are arranged according to the formula index system of von Richter. Where data are available the following information is given: molecular formula, expanded structural formula, Faraday number, names, the occurrence (with references), methods of preparation with references, physical form, melting and freezing points, boiling point, density, solubility in organic solvents and any other outstanding properties.

An extensive discussion of the nomenclature rules followed by an index of the compounds considered in the reference is provided. Care has been taken to avoid the principal use of so-called "trivial" names for many compounds, a desirable feature. However, these trivial names are not excluded to eliminate need for extensive "translations" and avoid making the references difficult to use. Where there is no agreement on "standard" nomenclature the various names are given, with preference left to individual choice.

All volumes are loose-leaf to permit ready insertion of additional and corrected information as issued by the publisher in the form of replacement sheets. These sheets contain precise instructions for insertion and deletion of obsolete material.

Obvious pains have been taken to assure accuracy. Since the "classical" references now are out of date and many of the supplements to them unavailable due to the war, the Encyclopedia bids fair to become the accepted English reference authority on organic compounds. The new system of organic notation invented by Dr. G. Malcolm Dyson—the Dyson cipher—is to be included as soon as the ciphering is completed. The sections on physical constants also will contain the preferred values appearing in *Physical Constants of Hydrocarbons*, by Dr. Gustav Egloff. Vol. 5 of the Faraday work, covering the $C_{10}H_6$–$C_{10}H_{14}$ hydrocarbons and now in preparation, will contain these new features as well as future Replacement-Addition Sheets for the present four volumes.

New *Replacement-Addition Sheets* for Vols. I, II and III also have been issued, which bring the information in these earlier references up to Jan. 1, 1948. A feature of these revision sheets is a listing of each page of the volume in the order in which they should appear, together with the date of issue, thus serving as a double-check for accuracy following insertion. The Dyson cipher, methods of special use in the laboratory, preferred values of physical constants and inclusion of all abstracting journal references appear in these latest revisions.

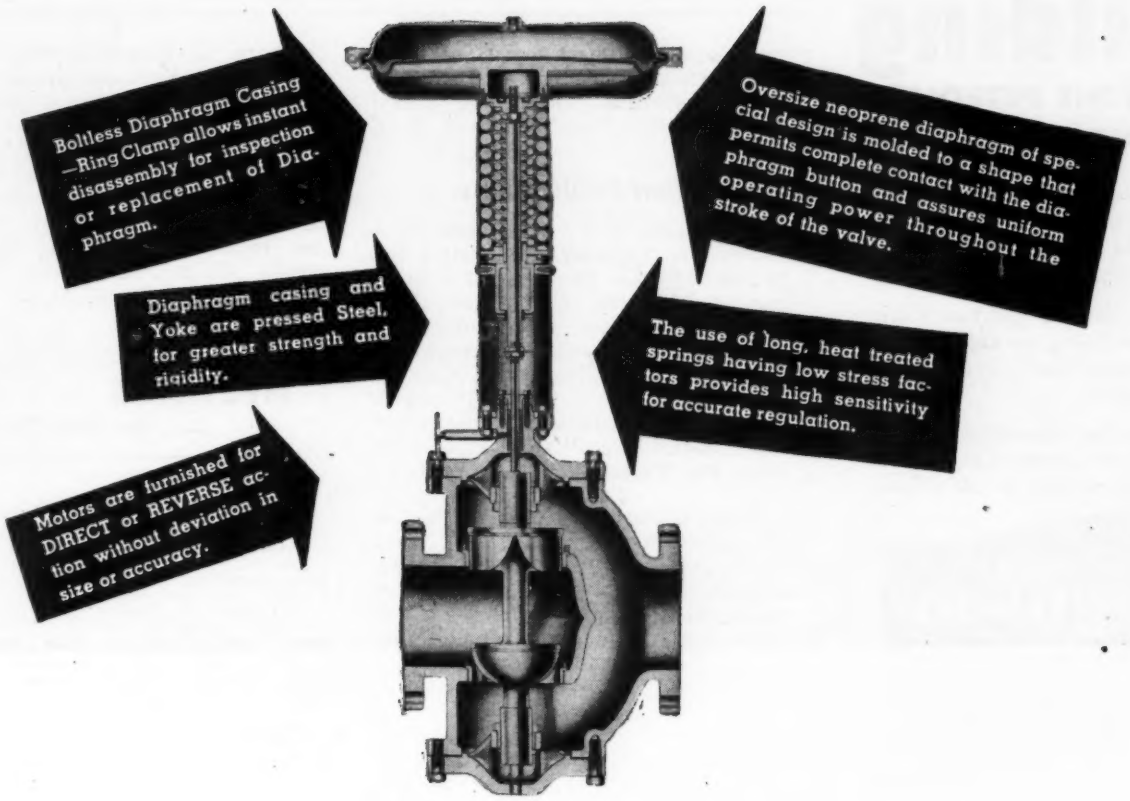
De Laval Publishes Revision Of Engineering Hand Book

De Laval Engineering Handbook; 5½ x 7¾ in., iv-370 pages, flexible cloth binding, illustrated, indexed, $2.00. De Laval Steam Turbine Co., Trenton 2, N. J.

This recently revised edition of the *de Laval Engineering Handbook*, just off the press, provides reference data, formulae, and general information useful to engineers concerned with such equipment as steam turbines, centrifugal and positive displacement pumps, centrifugal compressors, blowers, and exhausters, and reduction gears.

The material has been divided for convenience into six main sections covering these types of equipment, plus a general data section, and it has been well indexed. The general section includes useful tables such as functions of numbers, logarithms, and other mathematical tables, and many engineering data, formulae, and the like.

The book was compiled by de Laval's engineering staff and edited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Association Publications

Symposium on Industrial Gear Lubricants, Technical Publication No. 88; three papers presented at a meeting of Technical Committee B of Committee D-2 on Petroleum Products and Lubricants, American Society for Testing Materials, June 22, 1948 Detroit: 6 x 9 in., 24 pages, heavy paper binding, 75c per copy. Order direct from the ASTM, 1916 Race St., Philadelphia 3, Penna.

Water Pollution Abatement Manual for Insoluble and Undissolved Substances, Manual Sheet W-2, adopted August, 1949; 8½ x 10¾ in. 10 pages, looseleaf perforations, 20c per copy. Order direct from Manufacturing Chemists' Association, Inc., 246 Woodward Bldg., Washington 5, D.C.

Tank Car Loading and Unloading Platforms, Manual Sheet TC-7, 8½ x 10¾ in., 12 pages, looseleaf perforations, 20c per copy. Order direct from Manufacturing Chemists' Association, Inc., 246 Woodward Bldg., Washington 5, D. C.

American Standard Steel Pipe Flanges and Flanged Fittings, ASA B16e6-1949, Supplement No. 1 to ASA B16e-1939: 8 x 10½ in., 10 pages. Published by American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.

Symposium on Functional Tests for Ball Bearing Greases, presented at the 51st Annual Meeting of the American Society for Testing Materials, Detroit, June, 1948; 6 x 9 in., 104 pages, $1.75. Order direct from ASTM, 1916 Race St., Philadelphia 3, Penna.

Government Publications

Compilation of Thermal Properties of Hydrogen in Its Various Isotopic and Ortho-Para Modifications, by Harold W. Woolley, Russell B. Scott, and F. G. Brickwedde; National Bureau of Standards Research Paper RP1932; 8 x 10¼ in., 96 pages, 40c. Order from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

Unless otherwise indicated, copies of all books reviewed here may be ordered from the Reader's Service Department, Petroleum Processing, 1213 West Third Street, Cleveland 13, Ohio, for the price listed, postpaid. Ohio purchasers please add 3% tax. NOTE: publisher's prices are subject to change without notice.

Charts of Compressibility Factors and Charts Showing Quantities Delivered by Commercial Cylinders for Hydrogen, Nitrogen, and Oxygen, by Harold J. Hoge, Cyril H. Meyers, and Robert E. McCoskey; National Bureau of Standards Miscellaneous Publication M191; 8 x 10¼ in., 25c. Order from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

MEETINGS . . . for the Oil Man

SEPTEMBER

12-16, Instrument Society of America, Fourth Conference and Exhibit, Municipal Auditorium, St. Louis, Mo.
12-16, American Society of Mechanical Engineers, Instruments and Regulators Division Conference and Exhibit, Municipal Auditorium, St. Louis, Mo.
14-16, National Petroleum Assn., 47th Annual Meeting, Hotel Traymore, Atlantic City.
18-23, American Chemical Society, 116th National Meeting, Atlantic City, N. J.
24-27, American Institute of Mining & Metallurgical Engineers, Regional Meeting, Neil House, Columbus.
28-30, American Society of Mechanical Engineers, Fall Meeting, Lawrence Hotel, Erie, Pa.
30-Oct. 1, Colorado School of Mines, Mineral Resources Conference, Golden, Col.

OCTOBER

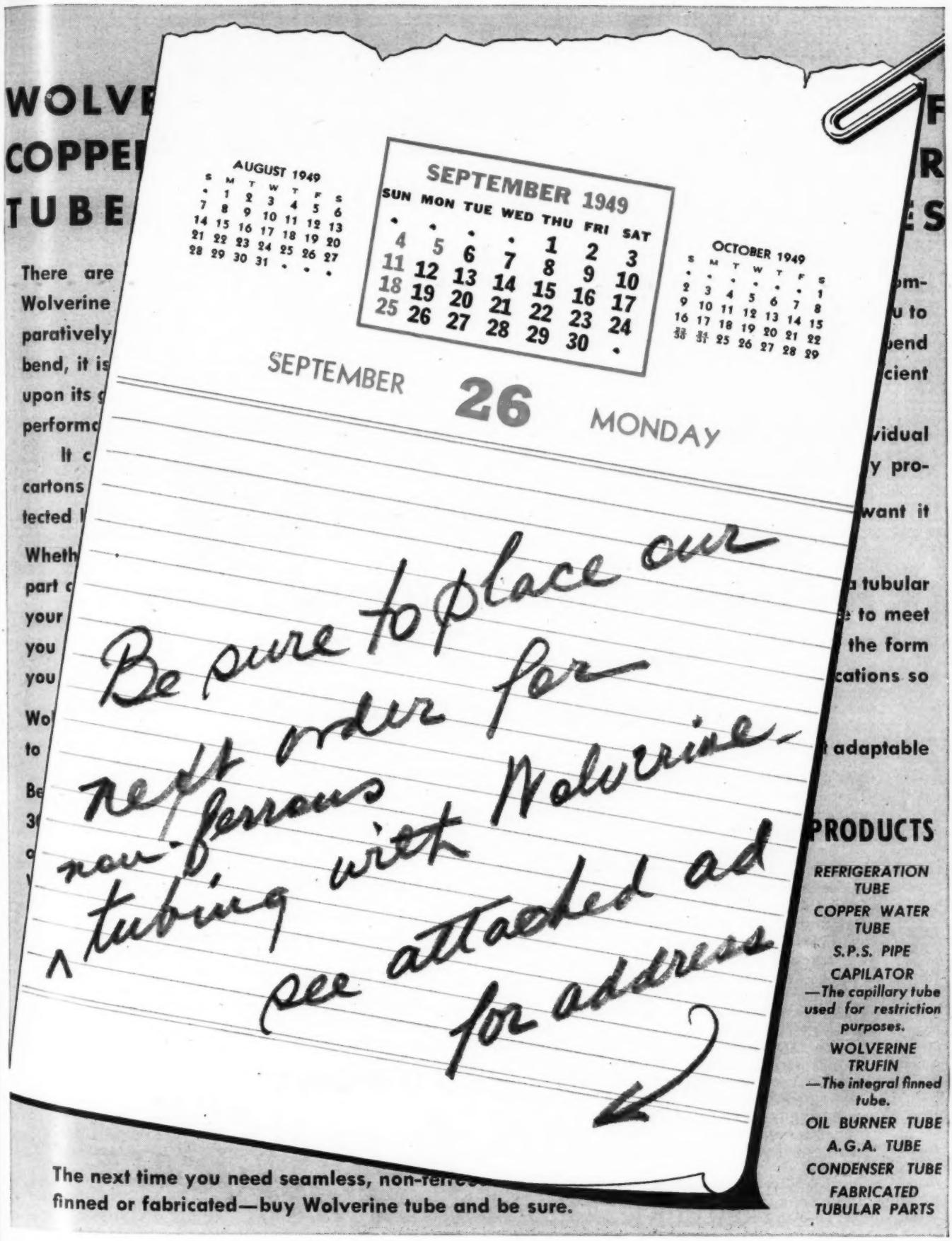
2-5, American Society of Mechanical Engineers, Petroleum Division, Petroleum Mechanical Engineering Conference, Biltmore Hotel, Oklahoma City.
3-4, National Assn. of Corrosion Engineers, Annual Meeting of South Central Region, Adolphus Hotel, Dallas.
3-5, National Lubricating Grease Institute, Annual Meeting, Roosevelt Hotel, New Orleans, La.
5-7, American Institute of Mining and Metallurgical Engineers, Petroleum Division, Fall Meeting, Plaza Hotel, San Antonio.
7, California Natural Gasoline Assn., 24th Annual Fall Meeting, Ambassador Hotel, Los Angeles.
10-14, American Society for Testing Materials, First National West Coast Meeting, Fairmont Hotel, San Francisco.
14, Natural Gasoline Assn. of America, Southern Regional Meeting, Blackstone Hotel, Tyler, Texas.
17-21, American Society for Metals, Annual Meeting, Public Auditorium, Cleveland.
17-21, American Welding Society, Annual Meeting, Public Auditorium, Cleveland.
20-21, American Institute of Mining & Metallurgical Engineers, Fall Meeting, Petroleum Branch, Elk's Club, Los Angeles.
25, Association of Consulting Chemists and Chemical Engineers, 22nd Annual Dinner Meeting, Shelburne Hotel, New York.
26-27, American Society of Mechanical Engineers, Fuels Division Conference, French Lick Springs Hotel, French Lick, Ind.

NOVEMBER

1-5, 2nd Pacific Chemical Exposition and Pacific Industrial Conference, Civic Aud., San Francisco.
3-4, Society of Automotive Engineers, Fuels & Lubricants Meeting, Chase Hotel, St. Louis, Mo.
4-5, The Society of Rheology, 20th Annual Meeting, Hotel New Yorker, New York.
7-10, American Petroleum Institute, Annual Meeting, Stevens Hotel, Chicago.
27-Dec. 2, American Society of Mechanical Engineers, Annual Meeting, Hotel Statler, New York.
28-Dec. 3, 22nd Exposition of Chemical Industries, Grand Central Palace, New York.

DECEMBER

4-7, American Institute of Chemical Engineers, Annual Meeting, William Penn Hotel, Pittsburgh.
9, Natural Gasoline Assn. of America, Panhandle-Plains Regional Meeting, Herring Hotel, Amarillo, Texas.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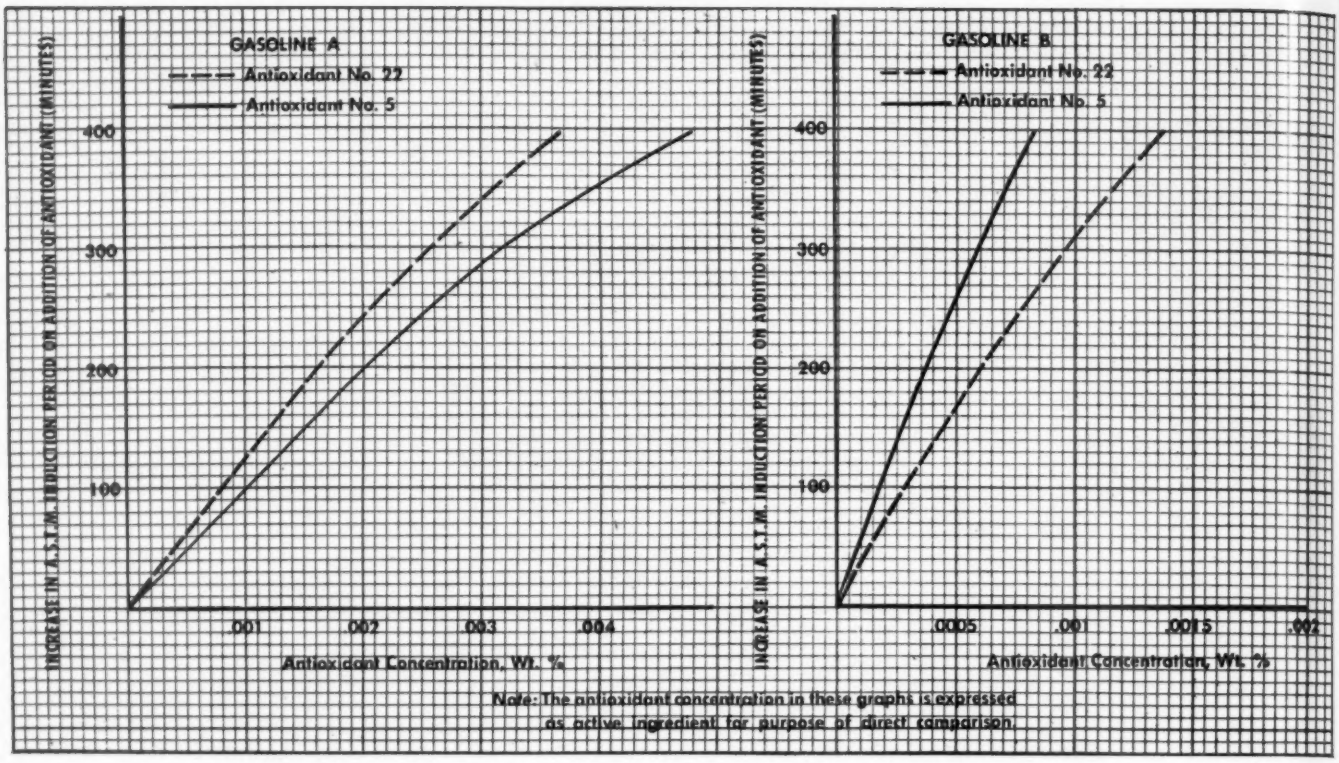

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Personals

J. B. Taylor, manager of the Gas Department, Signal Oil & Gas Co., is president of the California Natural Gasoline Assn., succeeding W. A. Kirk, California Southern Oil Co. A native of Oregon, he graduated in electrical engineering from Stanford University in 1926 and

Mr. Taylor

Mr. Tullin

became affiliated with Signal Gasoline Co. He became a member of the natural gasoline society in 1927 and has served on many of its technical committees.

R. S. Tullin, Shell Oil Co., Los Angeles, is vice president of the California Natural Gasoline Assn., succeeding Mr. Taylor. He started with Shell in 1920 as engineer in an electric plant and in 1923 became chief operator of its absorption plant at Santa Fe Springs. From 1925-30 he was in the Manufacturing Department, at the Wilmington refinery, as foreman and later assistant chief in charge of the gas and absorption plant. He later became superintendent of gas plants and since 1940 has been manager of the Natural Gas and Gasoline Division.

E. R. Millett, Jr., was re-elected secretary-treasurer of the California Natural Gasoline Assn.

* * *

D. F. Gerstenburger is district manager for Alcorn Combustion Co., at Tulsa to head up its new Southwestern Division. He was formerly with this company and has also held executive positions with several oil companies.

His first refinery job was with the New Jersey Standard at Bayway and, in 1920, he became assistant general superintendent at its Charleston, S. C., plant. He was district sales manager for Universal Oil Products Co. at Tulsa from 1931-36 and later was general manager of Inland Empire Refineries, at Spokane, Wash. After the war he headed a mission to conduct an economic survey of the petroleum industry in China.

* * *

Leigh D. Josephson is superintendent of personnel for the Bahrein Petroleum Co. Ltd., at their Bahrein, Persian Gulf, refinery. He was formerly assistant refinery superintendent and has been stationed at Bahrein since 1939.

* * *

William K. Whiteford, president of the British American Oil Co., Toronto, was elected a director of the Canada Life Assurance Co.

* * *

T. J. Gates was promoted to maintenance control engineer at the Torrance, Cal., refinery of General Petroleum Corp. He received a degree in chemical engineering from Wayne University, Detroit, in 1942 and joined General Petroleum Co. after four years in the Army in Chemical Warfare Service.

* * *

George S. Dunham was appointed vice-chairman of the manufacturing committee of Socony - Vacuum Oil Co. Inc., succeeding **Douglas L. Hooker,** now retired. He was formerly in charge of midwest refineries and pipelines, and in his new position assumes charge also of the eastern refineries and pipelines of the company.

Mr. Dunham

* * *

Ju Chin Chu is associate professor of chemical engineering at Polytechnic Institute, Brooklyn. Formerly a technologist with Shell Chemical Corp. in California, since 1946 he has been assistant professor of chemical engineering at Washington University, St. Louis. He holds a Sc. D. in chemical engineering from M. I. T.

* * *

Dr. Bruce H. Sage, professor of chemical engineering in California Institute of Technology, will be the first recipient of the new $1000 Precision Scientific Co. award in petroleum chemistry, to be presented Sept. 19th at the meeting of the American Chemical Society in Atlantic City. His many years of research in the thermodynamics and physical properties of petroleum hydrocarbons is credited with materially enlarging the recoverable oil resources of the U. S. The purpose of the award is to stimulate research in petroleum chemistry in the U. S. and Canada. His award address will be the "Status of Thermodynamics in the Petroleum Industry."

* * *

D. A. Shock is senior research chemist in charge of the production chemistry group in Continental Oil Co.'s production laboratory. He comes from the University of Texas, where he had been on the research staff in charge of corrosion research problems. He is a chemical engineering graduate from Colorado College and obtained his master's degree in chemistry from the University of Texas.

* * *

Heinz W. Sternberg is a research chemist in the research and development department of Atlantic Refining Co., Philadelphia. He was formerly with Paraffine Cos., Inc.

* * *

Charles E. Maschal, assistant manager of Sun Oil Co.'s Marcus Hook, Pa., refinery, was elected a director of Crozer Hospital, Chester, Pa.

* * *

T. V. Moore, Standard Oil Development Co., is the new chairman of the API advisory committee on fundamental research on the occurrence and recovery of petroleum. **H. G. Vesper,** California Research Corp., of Standard Oil Co. of California, is the new chairman of the API advisory committee on fundamental research on composition and properties of petroleum.

* * *

Harold M. Smith, principal petroleum chemist and assistant supervising engineer, at the Bureau of Mines Petroleum Experiment Station at Bartlesville, Okla., Aug. 30th received a gold medal and official citation from the Interior Department, in recognition of 26 years of distinguished government service.

Mr. Smith

Among his outstanding scientific contributions is the development of a correlation index to aid in the interpretation of crude oil analyses. During the war he was in charge of the preparation of confidential reports evaluating crude oil and distillates for aviation fuels and other war-needed products. He also worked on jet propulsion fuels and this work is being continued and now includes a project, in cooperation with the Western Petroleum Refiners Assn., to discover the relationships between

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Personals

the composition of distillates in the Diesel fuel range and their combustion characteristics. He also is a director for the API Research Project 48-A on sulfur in petroleum.

Mr. Smith received his A. B. and A. M. degrees in chemistry from Clark College, Worcester, Mass., in 1921 and 1922. He joined the staff at the Mines Bureau's Bartlesville station in 1923 and has remained a Bureau staff member since.

* * *

J. Donald Charlton has left the technical Service Department of Socony-Vacuum Oil Co. Inc., at Brooklyn, to become a process products engineer in Socony's foreign trade department and is located in Medellin, Colombia, S. A. He received his B. S. in chemical engineering at Armour (now Illinois) Institute of Technology in 1940 and his M. S. from Purdue University in 1942. He has been with Socony-Vacuum since except for two years in the Navy.

Mr. Charlton

* * *

Dr. Nils K. Anderson is director of research and development for Deep Rock Oil Corp. **Dr. Delton R. Frey**, recently named manager of products application, and **Jesse B. Jackson, Jr.**, with Dr. Anderson form the nucleus of the research staff being established by Deep Rock.

For the past three years Dr. Anderson has been associate professor of chemical engineering at Northwestern University. From 1941 to 1946, he was on the staff of Universal Oil Products Co. He received his B. S. degree in chemical engineering from Armour Institute of Technology, and his Ph. D. from the University of Wisconsin in 1941.

Dr. Frey received his Ph. D. from Case Institute of Technology in 1945. He came to Deep Rock from Anderson-Prichard Oil Corp. where he was head of the fuels and lubricating oil section. Prior to that time he was with B. F. Goodrich Chemical Co. and with Lubrizol Corp.

Mr. Jackson received his Masters degree this year from Columbia University and his B.S. degree from the University of South Carolina, following three years' active service with the Navy during the war.

* * *

Paul M. Pitts and **A. Ruth Johnson** are two new chemists on staff of the research and development department of the Atlantic Refining Co., Philadelphia. Mr. Pitts recently received his Ph. D. degree from the University of North Carolina, and

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Personals

is an associate chemist in the refining division. Miss Johnson, who received her M. S. degree from the University of Delaware, is a junior chemist.

* * *

C. P. McDonald has recently joined the production staff of Lion Oil Co.'s chemical division at El Dorado, Ark. He was previously with the organic department of duPont Co.

* * *

Kenyon B. Howard, chemical engineer, formerly with Standard Oil Co. of Calif., has opened an office and laboratory in Lindsay, Calif. to specialize in food production and processing problems.

* * *

Donald B. Pruess has joined the staff of Petroleum Advisors, Inc., in New York City as an engineer. He was previously connected with Cities Service Oil Co. in Bartlesville in a similar capacity.

* * *

J. R. Britt is now asst. general superintendent of the natural gasoline division of the Arkansas Fuel Oil Co., Shreveport, La. He was formerly process engineer in the manufacturing department of Petroleum Advisers, Inc.

* * *

Delbert L. Warwick, formerly chemist with General Chemical Co. and more recently with Shell Oil Co., has received an M. D. degree from the University of Texas Medical School and joined the staff of the U. S. Public Health Service.

* * *

Dr. Paul John Blatz is assistant research chemist on the research staff of Houdry Process Corp. He was formerly instructor in the chemistry department of Catholic University. He received his BS in chemistry from Fordham and his PhD in physical chemistry from Princeton.

* * *

Dr. M. King Hubbert, associate director of research of Shell Oil Co.'s exploration and production research laboratory, was named by Interior Secretary Krug as a delegate to the United Nations Scientific Conference on Conservation and Utilization of Resources at Lake Success, N. Y.

* * *

Frederick C. Loomis is oil purchase and exchange agent for Standard Oil Co. of California and will centralize activities previously carried on by a number of departments. In the company's natural gasoline department he became a specialist on organization and, since 1945 had been assistant manager of that department.

* * *

Harry L. Moir is manager of the marketing service departments of Pure Oil Co. at Chicago. He has spent the past several years in the company's technical laboratories.

ADVERTISERS' INDEX

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EDITORIAL VIEWPOINTS...

Opinions and Comments on Current Topics

New Approach to Sulfur Problem

VERY material savings in engine wear and improvement in engine cleanliness are reported by some oil companies, and by at least one Diesel engine manufacturer, as a result of experimental work on the new type high-additive oils. These oils, described in this issue, pg. 981, are a post-war development designed to relieve Diesel engines engaged in extreme heavy-duty service.

The available test data are sufficient to bring forward the possibility that the high rate of engine wear and engine fouling which frequently accompanies the use of high-sulfur Diesel fuels can be greatly alleviated through the selection of the crankcase lubricant.

The Caterpillar Tractor Co., through its research work, has established that the sulfur content of the fuel is the outstanding factor in the extent of wear and deposits in Diesel engines. It has also studied the degree to which these effects can be counteracted by the selection of the crankcase lubricant. As a result of its work a technical representative of that company called upon the petroleum industry to develop lubricating oils which would "help its engines to live with the fuels they will have to burn in the future". Shell Oil Co., Standard of California, The Texas Co., and Richfield Oil Corp., through their work with the new type oils, also have reported evidence of material reduction in engine wear with the new type oils, particularly where high-sulfur fuels were used.

This is a most important field for the petroleum and automotive industries to explore until most conclusive results have been achieved on a wide scale. It appears that increasing quantities of high-sulphur fuels will of necessity be used in this country and the foreign market is said to be now largely supplied with such fuels. If lubricating oils can be developed which will minimize the effects of sulfur in the fuels, great savings will be possible for refiners and for the engine operators.

Spotlight on Distillate Fuels

MORE attention was given to distillate and heavy fuel oils than to gasoline in the discussions on hydrocarbon fuels before the recent United Nations Conference on the Conservation and Utilization of Resources, at Lake Success. This emphasizes the world-wide scope of the economic trend which oil companies in this country have experienced in the past few years.

Technological developments, among them the improvement of the gas turbine and the expanding use of Diesel engines, are causing the scientists of other countries to look with concern at the growing consumption of distillate fuels. They give little consideration to any extensive utilization outside the U. S. of the lighter fuels for home heating. In fact, there was a note of reproach in at least one paper presented, on this use of light oils.

In this paper, two scientists of the Ministry of Fuel and Power in England stated that American demand for distillate fuels was responsible for a world shortage of this petroleum product. "Does not this (space heating) represent an extravagant use of the expendable resources of oil since, when oil becomes short and prices rise, there will have to be a reconversion to coal?" they ask. The convenience and cleanliness of oil should not be allowed to override considerations of its conservation, they conclude.

These same authorities foresee increasing use of Diesel engines in the heavier types of automotive vehicles, as well as in engines in marine and stationary service, because of their higher thermal efficiency and the resulting reduction in fuel used. However, such savings in fuel they see soon swallowed up by the increase in the number of engines in use consequent upon a rise in the standard of living of countries other than the U. S. The Director of Research of the Renault Works, in France, sees further technological developments in compression-ignition engines, but their wide use awaiting improvements in fuels and particularly lubricants, which will cut down their maintenance costs.

The future course in fuel utilization in aircraft engines was seen as involving a change from gasoline to kerosine or other fuels suitable for gas turbines. Aircraft engines could use the heavier fuels but the higher pour points would make them operationally unsuitable, it was brought out. Less definite predictions were made as to the future of gas turbines in general industrial use, though the need for their wide use was recognized because of their more efficient use of fuel.

This growing world-wide interest in fuels in the distillate range is significant to refiners in this country. It should further stimulate the work to develop methods to convert the heavy fuel oils into lighter products.

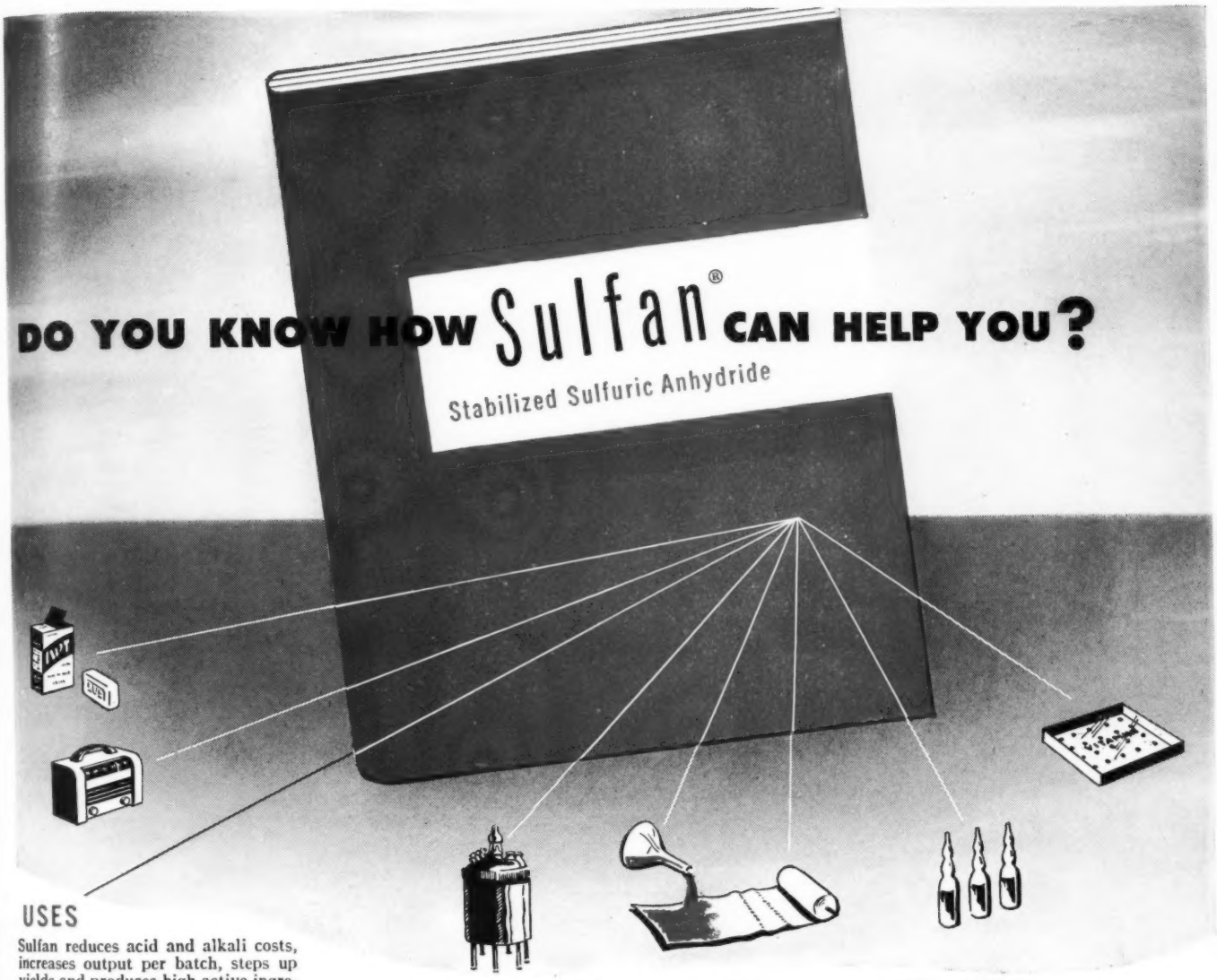
College-Industry Exchange

THE Foundation for Economic Education is providing business firms, oil included, the means for bringing into the teaching staffs of the colleges and universities a first-hand understanding of how business and industry function. Through an exchange program, fellowships are offered to economics teachers and research workers, covering six-weeks' study of a firm during the summer.

The firm pays the Fellow his transportation costs and $300 to cover living expenses for his study period. The companies provide for free and open observation of their operations and the Fellows are expected to approach their study in an open spirit of inquiry.

Started in 1948, encouraging experience the first year prompted the Foundation to broaden its program in 1949 and to include petroleum among other industries. The Texas Co. provided two fellowships. The fellowships are arranged through the Foundation, whose directors include top-level business men, industrialists and educators of the nation.

Teachers of economics too frequently move directly from their academic training into the teaching profession, with no opportunity to secure first-hand, on-the-job experience in business. The Foundation fellowships provide a means for them to get their own "feel" of business, and to understand some of the problems industry faces. The program should aid in breaking down the misunderstanding of business which too frequently exists in the economics teaching staffs.



USES

Sulfan reduces acid and alkali costs, increases output per batch, steps up yields and produces high active ingredient content or completely salt free materials in these reactions:

Sulfonation of alkylated aromatics to produce synthetic detergents
Sulfonation of fatty acids to give hydrolysis-resistant wetting agents
Sulfation of alcohols
Mono- and polysulfonation of aryl compounds to produce dyestuff intermediates
Direct sulfonation of aliphatic compounds

Sulfan also demonstrates advantages in the following applications:

Elimination of mixed sulfonates in benzenoidal sulfonations
Adjusting the concentration of high strength oleums
Fortification of spent sulfuric acid and oleum
Formation of addition compounds with amines
Direct production of sulfones

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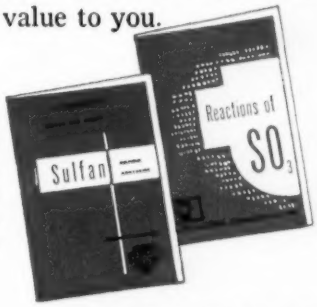
General Chemical Technical Service Bulletin SF-1 (SULFAN) and Technical Service Bulletin SF-2 (Reactions of SO_3) provide extensive data on the physical and chemical properties of "Sulfan," together with a summary of more than 400 references found in the chemical literature concerning the reactions of sulfuric anhydride. You will find these excellent source material for fundamental research and product development, as well as production.



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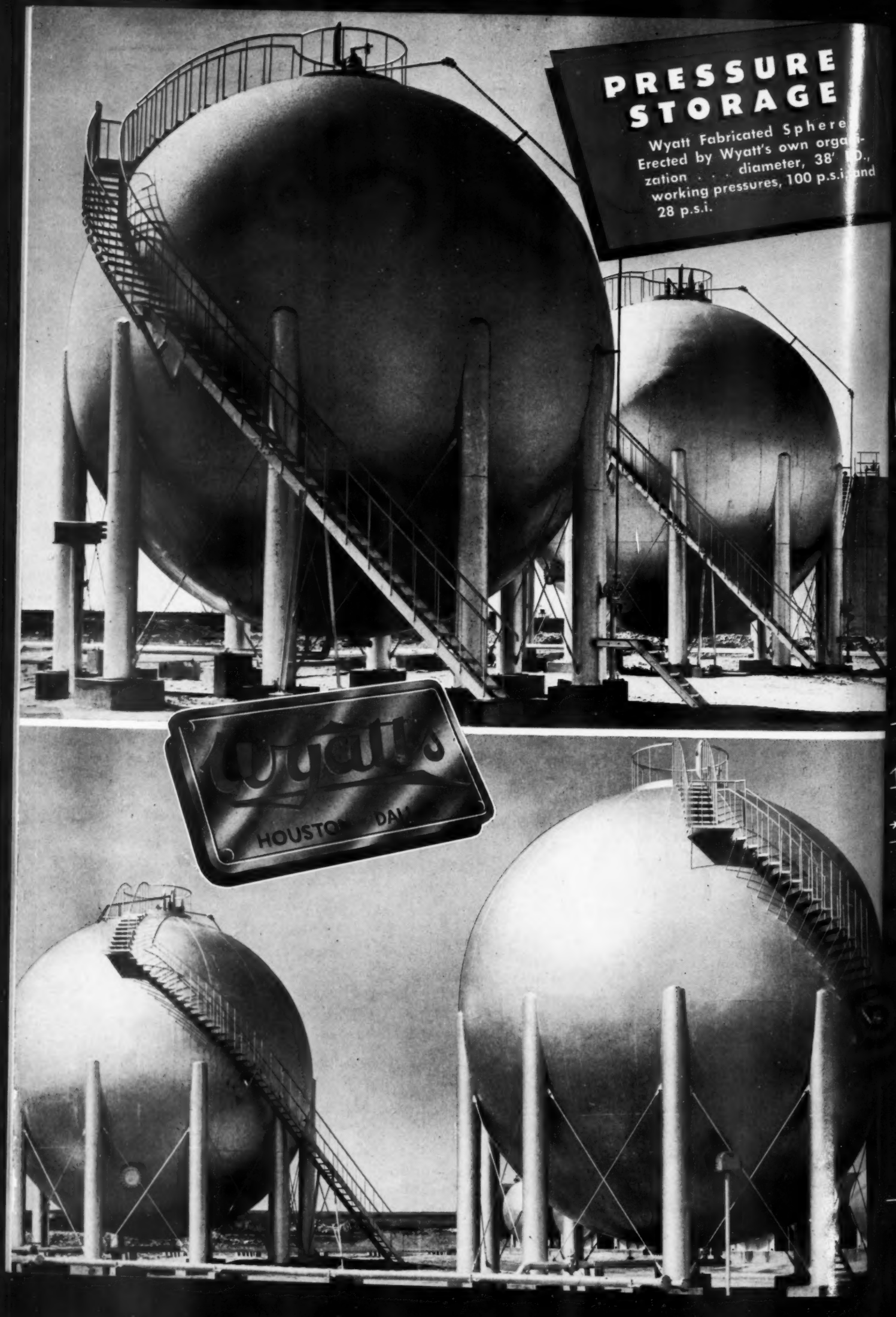
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